Screening Level Evaluation of an Off-site Relocation of the Large Tailings Pile

Homestake Mining Company – Grants Site

Prepared for:

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June 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The Homestake Mining Company (HMC)-Grants Site (herein referred to as the Site), located in Cibola County, New Mexico, is a Superfund site under the supervision of U.S. Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). The Site formerly housed a uranium mill facility. Groundwater remediation of the site has been conducted since 1977, and site reclamation began in 1990 with closure of the mill.

The purpose of this report is to explore costs, efforts, and regulatory requirements to be met under the alternatives of continuing with the current remediation and reclamation strategy or a hypothetical move of the tailings pile to a location outside of the San Andres Aquifer basin and the Village of Milan. With either alternative, on-site groundwater remediation would continue. For costing purposes, a distance of 30 miles was chosen in this evaluation because it would relocate the pile outside of the Village of Milan, outside of the San Andres Aquifer basin, and could potentially be in a location more distant from a population center and out of sight of the general public.

On-Site Remedy

HMC continues to control access to the Site while groundwater remediation is ongoing and final reclamation is planned. Regulatory responsibilities are currently shared by NRC, EPA, New Mexico Environment Department (NMED), and New Mexico Office of the State Engineer (NMOSE). The NRC oversees the groundwater remediation and describes the Site as being in the decommissioning phase. Final decommissioning will start after the completion of groundwater remediation.

Groundwater restoration at the Site commenced in 1977. The mill ceased operations in 1990 and was buried on-site. Under the on-site remedy alternative, groundwater remediation will continue until site closure standards have been achieved, consistent with the current CAP and NRC license. Groundwater remediation consists of a groundwater collection/injection system for the San Mateo Alluvial aquifer and the Upper, Middle and Lower Chinle aquifers, tailings collection wells within the tailings impoundment, tailings impoundment toe drains, and RO treatment plant, as well as three evaporation and two collection / storage ponds.

When groundwater remediation is deemed complete by the regulatory agencies, the RO plant, other buildings (if necessary), contaminated equipment, and contaminated piping will be demolished and placed in either Evaporation Pond #1 or #2 and permanently capped. Uncontaminated equipment and debris will be disposed of as appropriate.

Off-Site Alternative

Under the off-site remedy alternative, groundwater remediation would continue until site closure standards have been achieved, consistent with the current CAP and NRC license. When groundwater remediation is deemed complete by the regulatory agencies, the RO plant, other buildings (if necessary), contaminated equipment, and contaminated piping will be demolished and placed in either Evaporation Pond #1 or #2 and permanently capped as currently planned. Uncontaminated equipment and debris will be disposed of as appropriate. However, under the off-site alternative, the tailings of the Large Tailings Pile, radon cover, erosion cover, interim radon barrier, and any soil or other material in the Large Tailings Pile would be excavated and moved to a different location. For costing purpose, a hypothetical location approximately 30 miles from the current location was analyzed. Such a move could be accomplished via truck haul, rail haul, or slurry pipe. All three tailings relocation transportation options are discussed in this report and are summarized here.

The off-site disposal alternative for the HMC-Grants site is a hypothetical alternative and no specific location for relocation has been identified as part of this evaluation. Identifying such a location could be difficult based on siting criteria, environmental considerations, land ownership, regulatory requirements, and public acceptance. Prior to identification of a permanent disposal location, a variety of alternative disposal cell locations would need to be studied and evaluated. The primary efforts and actions associated with implementing the off-site disposal alternative include the following:

- Site identification, new siting studies, siting permitting, and public meetings
- Construction and operations at the permanent off-site disposal location, construction and operations at HMC-Grants, and construction of the transportation route
- Transportation of contaminated material from the HMC-Grants Site to the off-site disposal location
- Monitoring and maintenance of the off-site disposal location, transportation route, and HMC-Grants Site
- Long-term stabilization, surface reclamation, and site closure of both the HMC-Grants Site and relocation site and restoration of the transport route

Resource requirements for the off-site disposal alternative include: labor, equipment, fuel, water, land disturbance, electric power, sanitary waste disposal, and solid waste. Potentially applicable environmental laws and regulatory programs for an off-site relocation are listed below. The list is not meant to be comprehensive, as additional regulations could apply depending on the relocation site and transportation method used to relocate tailings.

Table ES-1. Potentially Applicable Environmental Laws and Regulatory Programs

Act/Regulation	Reference
Atomic Energy Act of 1954	42 United States Code [U.S.C.] 2011
Wildlife and Fisheries	50 CFR 36.39
CERCLA	42 U.S.C. 9620, 40 CFR 300
Clean Water Act	33 U.S.C. 1251 et seq., 40 CFR 330 Appendix A
Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et seq., 40 CFR 262 Subparts A–C
Wilderness Management Act	16 U.S.C. 1131
Endangered Species Act	16 U.S.C. 1531–1534
National Historic Preservation Act	16 U.S.C. 470, 36 CFR 63, 36 CFR 800
National Environmental Policy Act (NEPA)	
UMTRCA	
U.S. Nuclear Regulatory Commission Regulation (NUREG) 1620-Standard Review Plan	
Environmental Protection, General	*New Mexico Administrative Code:* Title 20, Chapter 1
Air Quality	*New Mexico Administrative Code:* Title 20, Chapter 2
Radiation Protection	*New Mexico Administrative Code:* Title 20, Chapter 3
Hazardous Waste	*New Mexico Administrative Code:* Title 20, Chapter 4
Petroleum Storage Tanks	*New Mexico Administrative Code:* Title 20, Chapter 5

Act/Regulation	Reference
Water Quality	*New Mexico Administrative Code:* Title 20, Chapter 6
Solid Waste	*New Mexico Administrative Code:* Title 20, Chapter 9
Licensing Requirements for Land Disposal of Radioactive Waste	*New Mexico Administrative Code:* Title 20, Chapter 3, Part 13

Costs, Impacts, and Schedule

On-site

The on-site alternative for final site closure is currently underway. Groundwater remediation has been ongoing for many years and is scheduled for completion in the near future. At such time, the Large Tailings Pile will be capped in place, and radioactive material and demolished buildings will be capped in one of the existing lined evaporation ponds. The tailings pile flushing program will be finished and monitoring of the groundwater will continue under the supervision and direction of DOE. Impacts to the environment, human health, and region have been evaluated and found to be minimal for leaving the Large Tailings Pile in its current location, as summarized in Table ES-2. No additional land will be disturbed by on-site closure. The cost to finish groundwater remediation and provide final site closure is estimated at $41.1 million with a final closure date of approximately 2017 (NRC, 2011) (Table ES-3).

Off-site

Impacts from the off-site disposal alternative are far more extensive and associated with much more uncertainty than the on-site alternative (Table ES-2). The costs for relocating the Large Tailings Pile range from about $1.8 billion (truck transportation) to over $2 billion (rail and slurry pipeline transportation) (Table ES-3). Costs for relocating the Large Tailings Pile are based both on site-specific considerations as well as using costs, labor, conceptual engineering designs, and risk estimates from the relocation of the Moab Tailings Pile. The Moab Tailings Pile is currently being moved approximately 30 miles from its present location.

The potential risk to human health is significant under the off-site disposal alternative. It is estimated, based on transport assumptions and accidents rates, that a worker fatality can be expected. Based on estimated exposure to radioactive material, the increased cancer risk to nearby residents would be approximately 1 in 100. Increased cancer risk to workers involved in tailings pile excavation and placement at the off-site disposal cell location is estimated at 1 in 10. All risk assumptions include conservative estimates that do not account for catastrophic releases or exposures.

Under the off-site alternative, the creation of a new disposal cell large enough to accommodate the tailings would require an extensive amount of land that will be irretrievably committed for perpetuity as a disposal cell. The removal of that land as habitat has the potential to adversely affect native wildlife that may be present, including elk, deer, antelope, Mexican spotted owl (threatened species), and native vegetation (including the Pecos sunflower, a threatened species) that have critical habitat in the vicinity of Grants. Additional evaluation would need to be conducted to determine whether any of the threatened species occur within any location selected for an off-site disposal cell. Evaluation of potential impacts to these species would require coordination with the U.S. Fish and Wildlife Service and New Mexico Department of Game and Fish. If potential impacts are projected, then measures would need to be taken to avoid or minimize impacts to the extent possible, and to mitigate for unavoidable impacts.

Potential impacts to an endangered or threatened species on federal land could require preparation of a Biological Assessment (BA) for review by USFWS, and impacts to a species on private lands could require development of a Habitat Conservation Plan (HCP).

Potential environmental impacts on federal land, which surrounds the Grants area, would trigger compliance with the National Environmental Policy Act (NEPA) and would likely require preparation of either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). State and federal lands include the Cibola National Forest, El Malpais National Conservation Area (managed by Bureau of Land Management), El Malpais National Monument (managed by the National Park Service), the West Malpais and Cebolla Wilderness Areas (BLM-managed as part of El Malpais National Conservation Area), and the Bluewater State Park (managed by New Mexico State Parks Division). Given the large number of cultural resources in the area and lands belonging to Native American tribes, environmental justice issues would also need to be examined prior to implementation of the off-site disposal alternative. There are many culturally important lands in the vicinity of Grants, and many are located near transportation routes or are adjacent to national forest.

Once the location of the off-site disposal cell is identified, transportation routes and methods must be approved by the U.S. and New Mexico Departments of Transportation and conform to all regulations regarding transport of hazardous material. The amount of truck traffic that would be generated by truck transportation of tailings is large and would have noticeable visual and noise impacts, a negative impact on air quality, and the potential for accidents and accidental releases. Rail transport may not have as much of an impact on traffic, but under any scenario additional workers would be needed at the HMC-Grants Site and the off-site disposal cell location, which will increase personal vehicle traffic with adverse impacts from vehicle emissions. In addition, trucking of borrow material to both the HMC-Grants Site and the off-site disposal cell location would increase traffic, the potential for traffic accidents, and have adverse impacts to air quality and noise.

Construction of the off-site disposal cell and related infrastructure development at both the HMC-Grants Site and the off-site disposal cell location would likely take up to three years to finalize and become operational, after all permitting and approvals are received. Construction of a rail line could take longer, depending on the distance. Construction will have negative noise and vibration impacts, which could be disruptive to residents and wildlife.

Monitoring of the off-site disposal cell location site would be required, from preconstruction to establish baseline conditions, through construction of the disposal cell and placement of tailings, to closure and long-term monitoring. Soil, vegetation, water, and air must be monitored, and if surface water bodies are present near the off-site disposal cell location, food, fish, surface water, and sediment samples must also be collected and monitored (NRC, 1980). Personnel must also be monitored for radiation exposure. All disposal cells will have the potential for leaks to develop or for releases to occur due to natural phenomena and leak detection monitoring will be necessary.

The off-site disposal alternative would involve a much greater use of consumable materials and fuel than the on-site alternative. This is an irretrievable commitment of resources and would produce greenhouse gas emissions.

Both the costs and schedule for the off-site alternative assume that construction of facilities and the transport route begins in 2017 (after groundwater remediation is complete and all structures except the Large Tailings Pile have been reclaimed). Siting studies, public hearings, environmental reports and pre-construction monitoring are estimated to take up to 7 years to complete, assuming a start date of 2013. Construction is estimated to take 3 years to complete, followed by 10 years of tailings transport, which would then be followed by reclamation of the Large Tailings Pile area, transportation infrastructure, the new disposal cell, and infrastructure at the new disposal cell. A work year of 365 days per year was assumed, with no interruptions to work for any reason. This is an aggressive schedule used for costing purposes and would not likely be achieved. Based on these assumptions, the off-site alternative would not be complete until the end of 2035.

Table ES-2. Potential Impacts of On-Site and Off-Site Alternatives

Category	On-Site Alternative	Off-site Alternative
Geology and Soils	No seismic potential	Seismic potential unknown
	Subsidence has been monitored and is not a factor at this time	Unknown, but minimized by design
	Decades after construction, Site is not a source of geological resources and land is already permanently unavailable	Geological resources at disposal site would become permanently unavailable; mineral rights of land holder would be terminated
	Borrow materials will be needed for permanent cover of large tailings pile	Borrow materials would be needed for cap of new disposal cell; borrow materials would still be needed for the HMC-Grants Site Large Tailings Pile footprint and cap. Estimates of material needed would be close to 3.5 million cubic yards
	No added potential for soil erosion	Excavation and construction for emplacement and removal of slurry pipeline would disturb topsoil and result in increase in potential for soil erosion along a pipe line corridor for the 30 mile hypothetical distance. Soil erosion could occur as footprint is backfilled.
Air Quality	Current air quality monitoring indicates no significant release of radon or particulates.	PM-10 emissions would require dust control measures; particulate emissions and radon emissions will increase
Groundwater	Groundwater impacts at the Site are well documented and currently being remediated.	Groundwater at the off-site disposal cell location could be impacted if a liner failed or other accidental release occurred. Groundwater would require monitoring. Groundwater impacts at the HMC-Grants Site would still be remediated even if the off-site disposal alternative were to be implemented, so there is no cost savings.
	Groundwater extraction would continue at current rate for groundwater remediation	Additional groundwater would be needed for the off-site disposal alternative, and additional time would be needed to complete groundwater cleanup.
Surface Water	No on-site surface water is present	Surface water bodies could be present at the off-site disposal cell location or along the transportation corridor that could receive accidental release of materials. Surface water bodies at the off-site disposal cell location could receive wind-dispersed particulates.

Category	On-Site Alternative	Off-site Alternative
Floodplains and Wetlands	Site is not in a floodplain and no wetlands are located in the vicinity	Potential to impact wetlands would need to be evaluated for any site selected as the off-site disposal cell location. Areas within a floodplain would not be acceptable.
Aquatic Ecology	No potential impacts to aquatic ecology from on-site alternative.	Aquatic ecology impacts are possible, depending on the off-site disposal cell location and transport route.
Terrestrial Ecology	No additional impacts are expected from on-site alternative. Area is not available for habitat at this time.	Habitat destruction is unavoidable.
Land Use	Land area of HMC-Grants Site will not be developed and is dedicated to groundwater reclamation until permanent closure.	Any land taken for the off-site disposal cell will be permanently unavailable for any other purposes (estimated area of 1000 acres).
Cultural resources	Location of the HMC-Grants Site is not in a cultural resource area.	Cultural resources and Native American lands occur within the vicinity of Grants and could be impacted by implementation of the off-site disposal alternative. At a minimum, the potential impacts of the off-site disposal alternative would need to be evaluated.
Noise and Vibration	Until closure of facility, no noise or vibration is expected. When tailings piles and ponds are closed in place, noise and vibration from building demolition and movement of cover materials is expected. Duration of impacts is not expected to exceed 2 years.	Noise and vibration from excavation and transport of tailings is expected year-round for a minimum of 10 years, plus construction noise and vibration for at least 2 years prior to tailings move. Additional noise and vibration would be expected during backfill and closure of Large Tailings Pile footprint, expected to take at least 1 year. In addition, building demolition and evaporation pond closure would still occur as planned and would result in additional noise and vibration for 2 years prior to construction start. At the off-site disposal cell location, construction noise will occur while building the disposal cell and associated infrastructure (at least 2 years). Noise and vibration associated with relocation of the tailings would occur for a minimum of ten years. Additional noise and vibration from transport and placement of cover material would occur for up to 8 years.
Visual Resources	Tailings pile is visible from road and nearby residences, and would remain visible after closure. Reclamation design could minimize visual impact. Pile has been at current location for over 50 years.	Off-site disposal cell will disturb any area that is selected as a relocation site. Over the estimated 10-year project, visual impacts would be moderate to severe. After closure, visual impacts could be moderated by design, but the land would not return to its native state.

Category	On-Site Alternative	Off-site Alternative
Infrastructure, Construction, and Resource Requirements	Industrial water supply in place. All necessary infrastructure already in place. No additional construction or infrastructure is needed.	Infrastructure at HMC-Grants would need to be expanded to accommodate larger work force and extensive program needs. Drying areas and staging areas would need to be constructed. Depending on transportation mode selected, slurry pipeline, conveyor belts, rail car loading areas or rail would need to be constructed. Additional buildings would need to be constructed at the HMC-Grants Site. Off-site buildings will be required. Electricity and water supplies would need to be secured for the off-site disposal cell location. Sanitary and solid wastes would need to be disposed of. All terminal process buildings and structures would need to be constructed.
	Current water demands known and met; water for dust minimization will be needed for site demolition and decommissioning.	Water for dust minimization will be needed; needs will exceed those of the on-site alternative and will create a new demand for water at the off-site disposal cell location
	Fuel will be needed for equipment used to provide demolition of buildings and final closure to Site.	Fuel needed for transport of tailings is estimated at up to 550,000 gallons per year for truck transport. Additional fuel would be consumed by transport of borrow materials, equipment used to construct and then cover the off-site disposal cell, and personal vehicles used by workers.
	No additional buildings are needed or will be built. Current buildings will be demolished on-site at final closure and capped in an existing evaporation pond.	Buildings will be needed for workforce at the off-site disposal cell location and HMC-Grants Site. Buildings/structures will be required at HMC-Grants and disposal cell for transport of tailings (type depends on transportation mode selected).
	Sanitary waste generation is not expected to significantly increase from current levels.	Generation of sanitary waste will increase at the HMC-Grants Site. Off-site disposal cell facilities for sanitary waste will need to be developed.
Waste management	Waste currently disposed of at municipal landfill. Slight increase in waste expected from closure of facility but would not overwhelm municipal landfill capacity.	Based on Moab estimates, an additional 1,040 cubic yards of solid waste would be generated and require disposal in a municipal landfill. Over 10 years, solid waste generated would total 10,400 cubic yards.
Socioeconomics	Slight increase in workers required for closure; temporary housing needs could be met locally or from nearby municipalities.	Increase in local spending would be expected to meet the demands of a larger workforce for the time period of construction and excavation, transport and placement of the tailings.

Category	On-Site Alternative	Off-site Alternative
Human Health	Human health impacts are not expected to change from current levels, which have been noted as minimal by ATSDR and are being analyzed by EPA for off-site radon exposure.	Increase in exposure to radon, radioactive particulates, and direct gamma radiation will occur to workers and potentially to off-site receptors. The estimated risk to off-site residents near the HMC-Grants Site from excavation of the tailings pile is 1 in 100 of developing a cancer. There is an estimated 10% risk of cancer to tailings excavation and placement workers.
Traffic	Little increase in traffic is expected from on-site closure. Increase would be short-term (2 years).	Significant increases in traffic would be expected and would last for the duration of the project (minimum 10 years).
Environmental Justice	HMC-Grants is not a cultural heritage site.	Many cultural heritage sites are within the vicinity of the HMC-Grants Site. Transportation of tailings could cross through culturally important properties and the off-site disposal cell could adversely affect heritage sites.
Disposal Cell Failure	Site monitoring is in place and conditions have been monitored for many years. Any change in conditions would be quickly recognized. Site is not within a floodplain or area of seismic activity.	Unknown consequences; consequences would depend on location of off-site disposal cell and surrounding environment.
Transportation Accidents	Not applicable.	Estimates show likelihood of fatal accident and release of radioactive material to the environment.

Table ES-3. Cost Estimate (in millions of dollars)

Remedial Action Component	On-Site Alternative (1)	Off-site Alternative		
		Truck	Rail	Pipeline
Tailings Facility Closure/Reclamation	$14.3	$13.3	$13.3	$13.3
Other On-site Demolition	$0.2	$0.2	$0.2	$0.2
On-site Water Treatment	$12.5	$12.5	$12.5	$12.5
On-Site Monitoring/Regulatory	$1.8	$1.8	$1.8	$1.8
On-Site Administrative, General, Security, Maintenance, and Holding	$6.3	$6.3	$6.3	$6.3
Subtotal	$35.0	$34.0	$34.0	$34.0
Siting Studies/EIS	NA	$12	$12	$12
Site Characterization (2)	NA	$7.5	$7.5	$7.5
Environment, Health and Safety, NEPA	NA	$78.8	$80.2	$45.5
Remedial Action Design (2)	NA	$9.4	$9.4	$28.1
Site Acquisition (3)	NA	$20	$20	$20
Remedial Action Field Management	NA	$45	$45	$45
Site Preparation (2)	NA	$149.1	$191.7	$404.5
Construction Costs (4)	NA	$255.9	$263.4	$350.3
Transportation Equipment, Fuel. Labor, and Maintenance	NA	$76.0	$41.5	$31.8

Remedial Action Component	On-Site Alternative (1)	Off-site Alternative		
		Truck	Rail	Pipeline
Tailings Handling	NA	$591.3	$795.0	$620.9
Cover Material	NA	$142.0	$142.0	$142.0
Erosion Protection (2)	NA	$20.2	$20.2	$20.2
Site Restoration (2)	NA	$26.7	$31.4	$39.8
Surveillance and Maintenance (5)	NA	$4.2	$4.2	$4.2
Project Management	NA	$49.7	$49.7	$49.7
Total	$44.8	$1521.7	$1747.2	$1855.6
15% Contingency	$6.7	$228.3	$262.1	$278.3
NRC Long-Term Maintenance/Surveillance Fee (6)	$0.8	$1.6	$1.6	$1.6
TOTAL	$52.3	$1,751.6	$2,010.8	$2,135.5

(1) On-site alternative costs are from HMC-Grants 2011 NRC-approved budget estimates. Note that the HMC-Grants closure/reclamation budget shown for the off-site alternative was decreased by $1 million for the off-site design alternative to account for exclusion of the LTP cap.

(2) Off-site alternative costs are based on cost estimates provided in the Final EIS for Moab (2005), tripled to account for adjustments made to Moab budget after 2007 that indicated an approximate threefold increase in total project costs from original estimates, plus a 25 percent increase to account for inflation from 2003 to 2012 (http://www.usinflationcalculator.com/), and 25 percent increase to account for larger mass of material to be moved.

(3) An estimate of purchasing land, mineral rights, water rights, and lease of any land needed for access roads, rail or slurry construction.

(4) Construction costs include all costs associated with construction and maintenance of process and transport buildings and equipment at both origin and terminal locations, and construction and maintenance of the transport route.

(5) Based on general maintenance costs to end of project (office maintenance, etc.) and surveillance/security costs for both origin and terminal locations.

1.0 INTRODUCTION

The Homestake Mining Company (HMC)-Grants Site, located in Cibola County, New Mexico, is a Superfund site under the supervision of U.S. Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). The Site formerly housed a uranium mill facility. Groundwater remediation of the site has been conducted since 1977 and site reclamation began in 1990 with mill closure and subsequent demolition of the mill.

The purpose of this report is to explore costs, efforts, and regulatory requirements to be met under the alternatives of continuing with the current remediation and reclamation strategy or a hypothetical move of the tailings pile to a location outside of the San Andres Aquifer basin and the Village of Milan. With either alternative, on-site groundwater remediation would continue. For costing purposes, a distance of 30 miles was chosen in this evaluation because it would relocate the pile outside of the Village of Milan, outside of the San Andres Aquifer basin and could potentially be in a location more distant from a population center and out of sight of the general public.

Section 1.0 of this report provides a history of the site and a discussion of regulatory involvement to the present time. Section 2.0 provides a description of the on-site and off-site alternatives reviewed. Section 3.0 describes the environmental considerations involved in an off-site relocation. Unavoidable impacts and irretrievable commitments of resource are discussed in Section 4.0. Section 5.0 lists regulatory requirements that would need to be met in order to pursue any off-site movement of materials. Section 6.0 compares the alternatives from environmental, community, and financial standpoints.

1.1 Regulatory Requirements

The reclamation of HMC-Grants is currently overseen by the NRC in conjunction with EPA as provided in a Memorandum of Understanding (MOU) between the agencies. The State of New Mexico Environmental Department (NMED) provides remediation goals for the groundwater as well as regulating groundwater remediation. Other regulatory agencies include the Department of Energy (DOE), Agency for Toxic Substances and Disease Registry (ATSDR), and the New Mexico Office of the State Engineer (OSE).

Remedial decisions for the Site are documented in detail in the 1989 Record of Decision (ROD) (EPA/ROD/R06/050, 1989), the NRC Source Material License SUA-1471, and NRC-approved Reclamation Plan for the Site, NRC-approved Groundwater Corrective Action Plan (CAP) for the Site, and the NMED-approved Discharge Plans DP-200 and DP-725.

As stated by EPA in the second five-year review of the HMC-Grants Site (EPA, 2006):

> *The remedial action objectives for ground water restoration (OU1) are defined in the NRC License SUA-1471 and NRC-approved ground water CAP, the NMED DP-200, and the 1983 Agreement between the EPA and HMC. The remedial action objectives for decommissioning the mill, surface reclamation, long-term stabilization of the tailings and closure (OU2) are defined in the NRC License SUA-1471. Since the ROD for Radon (OU3) called for no further action, no remedial action objectives were set for this operable unit under [Comprehensive Environmental Response Compensation and Liability Act] CERCLA (EPA, 1989). In general, the objectives of the remedial activities are to:*

> *(1) limit radon emissions from the tailings impoundments;*
>
> *(2) remediate contamination in soil that resulted from windblown tailings;*
>
> *(3) remediate ground water to levels stipulated in the NRC License SUA-1471 and the NMED DP- 200;*
>
> *(4) dewater the large tailings impoundment to remove this area as a continuing source of ground water contamination; and*
>
> *(5) prevent the consumption of contaminated ground water by residents in the Subdivisions.*

This evaluation of remediation alternatives focuses on current activities and provides an analysis of issues associated with a hypothetical relocation of the Large Tailings Pile. Such an action would be subject to regulations of the NRC, EPA, DOE, other federal entities and federal regulations, NMED, other state agencies, state regulations, and county and local governments and ordinances of the relocation site. These regulations are described throughout the evaluation as a source of guidance; there is no regulatory requirement for the relocation of the Large Tailings Pile. Any specific goals and requirements would be contingent upon discerning a relocation site and all regulations, laws, statutes, and ordinances applicable to the location, as well as identification of all potential stakeholders in such an undertaking and their rights under all applicable laws. It should be noted that EPA and NRC agree that a tailings pile move is not required at this site. Specifically, EPA states (EPA, 2011a):

> *...HMC is responsible for the clean-up and is operating under an NRC approved reclamation plan where partial surface reclamation has occurred and final surface stabilization will occur after ground water remediation is complete. Ground water remediation is occurring. The reclamation plan and remediation is designed to be protective of public health and safety. The environmental clean-up is ongoing. The licensee has not proposed moving the tailings and NRC has no basis to require it.*

In the Remedial Systems Evaluation conducted for the Site (USACE, 2010), Recommendation #11 specifies that relocation of tailings should not be considered further due to risks to the community and the U.S. EPA agreed with this recommendation (EPA, 2012).

1.2 Background

This section of the report describes the existing site conditions, including the site location and climate, the operational history, a history of the groundwater remediation, the geologic and hydrologic setting, background water quality, hazardous constituents, existing groundwater monitoring and current conditions, and a summary of the surrounding land and groundwater use.

1.2.1 History of Site

The HMC-Grants Site is located in Cibola County, New Mexico, approximately 5.5 miles north of the Village of Milan and near the town of Grants, New Mexico in Section 26, Township 12 North, Range 10 West (Figure 1-1). The Site is accessible from New Mexico Highway 605, approximately 85 miles west of Albuquerque, New Mexico. The surrounding area is used for residential, agricultural, and commercial purposes. To the south-southwest of the Site within a

2-mile radius are five low-density residential subdivisions (Felice Acres, Broadview Acres, Murray Acres, Pleasant Valley Estates, and Valle Verde), while large areas to the north and west of the Site are used for grazing. Commercial properties are located to the east of the Site, on the opposite side of Highway 605, as well as further south and southwest of the Site past the residential subdivisions (Figure 1-2).

The HMC-Grants Site is at an elevation of 6,600 feet above mean sea level (MSL). The site is in the high southwest desert setting with a semi-arid, temperate climate, an average precipitation of 10.4 inches per year, and evaporation of 54.6 inches per year.

The HMC uranium mill operated through various partnerships from 1956 until 1990. HMC operated five underground mines that provided ore for the mill, and toll milled uranium ore for other mining companies. Uranium ore was trucked to the site from the various mine locations. Two mills were built on the site; the large mill and the small mill. The mills were combined into one operation in 1961. After combining the two mills, the facility throughput was approximately 3,400 tons per day (tpd) using an alkaline leach process. In total, the mill produced approximately 83 million pounds of uranium oxide (U_3O_8) from 1956 to 1990. In the process, more than 22 million tons of tailings, now located in two tailings piles, were also produced. Tailings were pumped to the tailings disposal cells as a slurry. The mill was decommissioned and demolished between 1993 and 1995. The debris was buried at the former mill site. The tailing piles were closed and covered by interim covers upon closure of the mill, and windblown materials from the tailings piles were scraped from surrounding areas and placed on the piles before covering.

The HMC-Grants Site now consists of the buried mill; two tailings piles; three evaporation ponds; a reverse osmosis (RO) plant; groundwater reclamation system including four irrigation systems; more than 600 wells for monitoring, groundwater injection, and collection purposes; and an office complex (administrative and maintenance buildings).

The tailings piles are the Large Tailings Pile (approximately 200 acres and 100 feet high) and the Small Tailings Pile (40 acres and approximately 25 feet high); together these contain approximately 22 million tons of tailings. The Small Tailings Pile is currently situated partially beneath Evaporation Pond #1 (see Figure 1-2, from HMC et al., 2012c).

All of the uranium processed at the HMC-Grants mill between 1958 and 1973 was mined from 1958 to June 1970 for the federal government under contracts with the Atomic Energy Commission (AEC). Of the 22.28 million tons of tailings at the Site, about 51 percent (11.4 million tons) are wastes associated with the AEC contracts.

In September 1983, the HMC-Grants Site was placed on the CERCLA National Priorities List (NPL). In June 1987, HMC entered into an Administrative Order on Consent (AOC) to evaluate potential radon exposure and effects to residents of the residential subdivisions nearest the site. In September 1989, EPA issued a ROD, which stated that no further action was required with respect to radon because the mill was not contributing significantly to off-site radon concentrations. The ROD also directed that potential impacts from releases to groundwater would be addressed by the NRC via the Site license (SUA-1471).

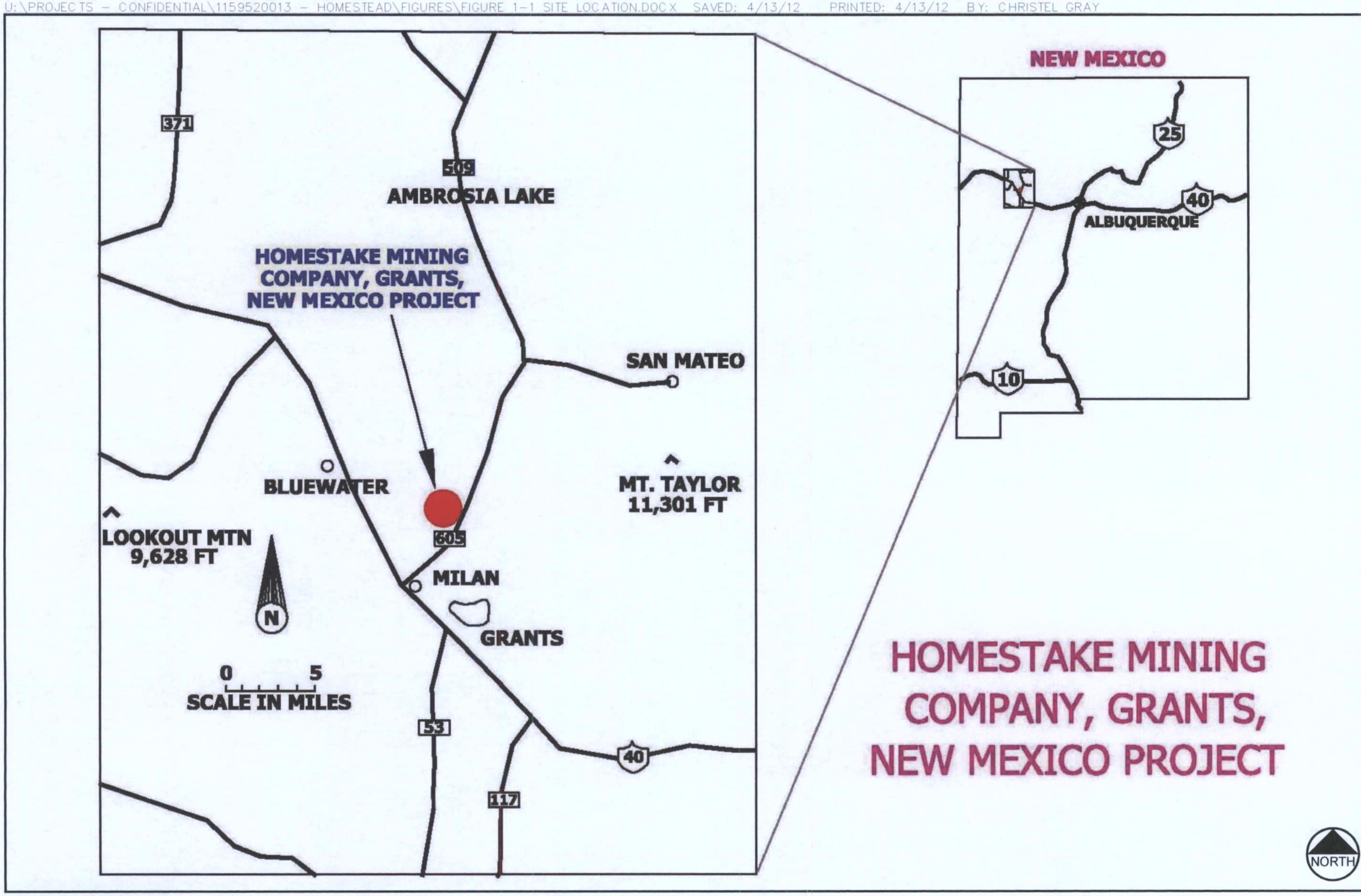
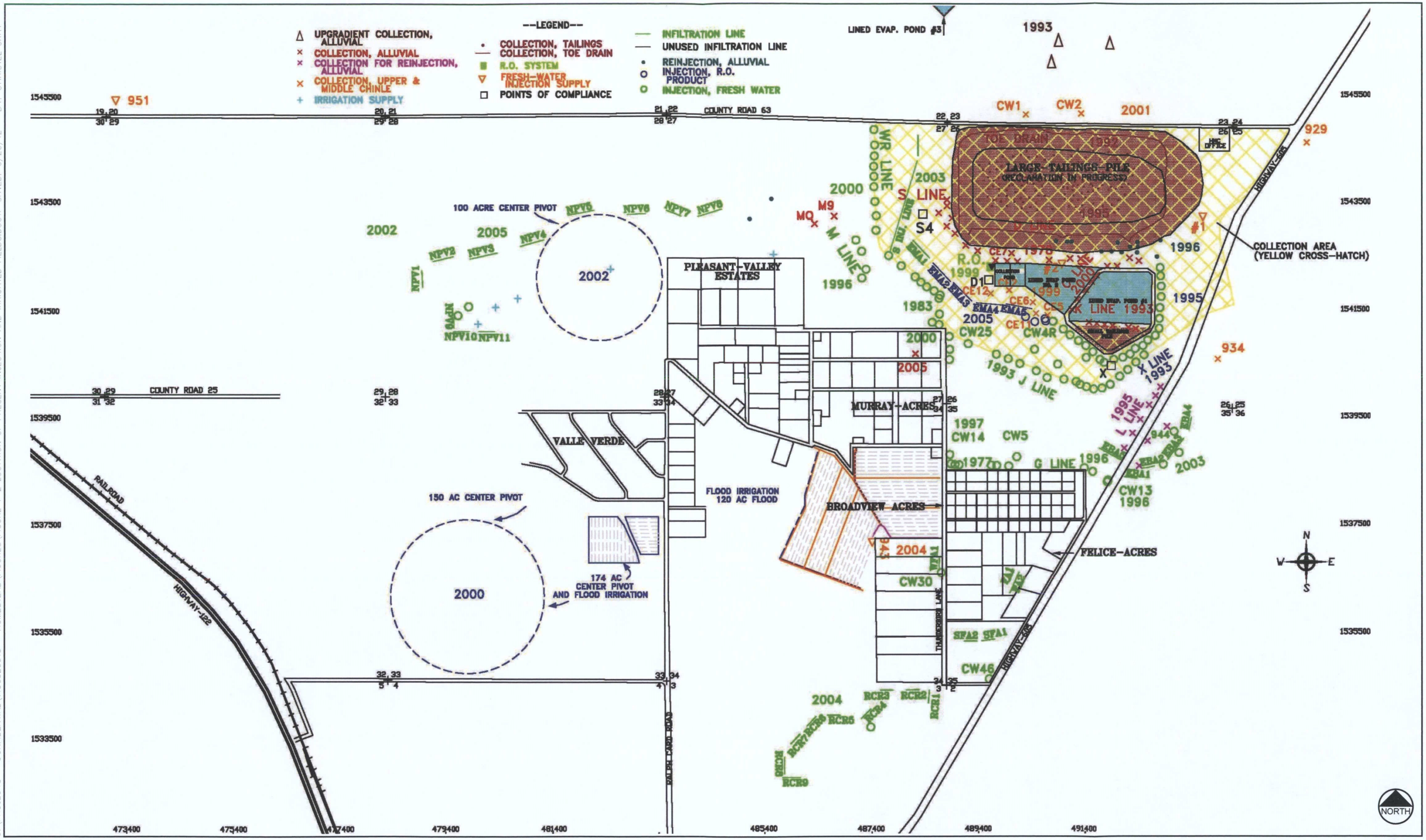


Figure 1-1
Location of the Grants Project



Project No. 1159520013

June 2012

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Figure 1-2
Location of Present Injection Wells and Irrigated Fields

Since that time, groundwater remediation has continued and been modified in response to monitoring results. A bullet summary of the key milestones of the groundwater restoration program is as follows (Figure 1-2), which are detailed in the Corrective Action Program report (HMC et al., 2012a):

- 1976 – Agreement between NMED and HMC on a Corrective Action Program. This pre-dates the Discharge Plan program.
- 1977 – Freshwater injection into six alluvial wells on the north side of Broadview Acres was initiated (the G line).
- 1978 – The S and D line collection wells were installed.
- 1980 – Start of Murray Acres collection program by pumping two alluvial wells.
- 1981 – Two additional Murray Acres collection wells were added.
- 1982 – Additional collection wells were added on the D collection line. Eleven injection wells were also added on the north side of Broadview Acres, extending the freshwater injection line to the east along the G line injection wells.
- 1983 – The M injection line was added on the north side of Murray Acres.
- 1984 – Injection into Upper Chinle well CW5 was initiated. Hearings on and approval of discharge plan DP-200 occurred.
- 1986 – Installation of the Milan water supply for Broadview, Felice, Murray Acres, and Pleasant Valley estates subdivisions.
- 1989 – Renewal of DP-200. NRC CAP was developed.
- 1990 – The Murray Acres collection system was modified by closing well AW and adding collection wells E, Z, and JC. Injection well AW (Murray Acres) and wells GW1, GW2, and GW3 (north of Broadview Acres) were added to the injection system. Use of Evaporation Pond #1 started in November. Approval of discharge plan DP-275 occurred.
- 1992 – Toe drains were installed around the tailings.
- 1993 – The last two Murray Acres collection wells were turned off and three wells in the K line were added to the collection program. The upgradient P wells started pumping the upgradient alluvial water and transferring it to the drainage to the west. The west side of the Large Tailings Pile was re-contoured. The GW injection wells ceased operation in early May, and the start of the J injection line occurred.
- 1994 – Additional K line wells were added. The east side of the Large Tailings Pile was recontoured.
- 1995 and 1996 – Additional downgradient wells were drilled in the alluvial and Chinle formations.
- 1995 – Tailings dewatering of the Large Tailings Pile were initially tested. The C collection wells were initially used. Injection into Upper Chinle well CW5 was ceased in mid-May.
- 1996 – Collection of lower concentration water for re-injection into the higher concentration areas in the alluvial aquifer was started. The M injection line was extended to the north. Usage of Evaporation Pond #2 began in March. Freshwater injection started in Upper Chinle well CW13.

- 1997 – Injection into Upper Chinle well CW5 resumed. Injection into Middle Chinle well CW14 was initiated in December. Additional M injection wells were installed.
- 1998 – Injection into Murray Acres well AW was ceased in May. Additional upgradient collection wells were added.
- 1999 – The RO unit was added to treat water and produce RO product water for injection into the alluvial aquifer. Upper Chinle well CE2 collection was initiated.
- 2000 – The M injection line was moved to the WR injection line. Initiation of irrigation of 270 acres was started. Injection into Upper Chinle well CW25 started. The source control program (flushing program) for the Large Tailings Pile began.
- 2002 – 60 acres of irrigation area were added. Freshwater injection started in Section 28. Freshwater injection into Upper Chinle well 944 was initiated. Freshwater injection into the alluvial aquifer east of Felice Acres was initiated. Freshwater injection east of Broadview Acres was initiated.
- 2003 – The freshwater injection line west of the Large Tailings Pile was added. Freshwater injection into Section 3 was initiated.
- 2004 – 24 acres of flood irrigation area were added in Section 33. Injection lines were added in Section 3. Injection lines were added east of Broadview Acres and in southern Felice Acres.
- 2005 – 40 acres of irrigation were added to the Section 28 center pivot. The S injection line west of the Large Tailings Pile was extended to the north. Freshwater injection lines NP1 through NP8 were added in Sections 27 and 28. Injection into NP1 through NP6 was initiated. Three freshwater injection lines were added to the east of the Large Tailings Pile. Freshwater injection lines EBA3 through EBA5 were added near the L collection line. Injection lines EMA1 through EMA5 were added to the south and west of the Large Tailings Pile. Freshwater injection into EMA1 and RO product water into EMA2 through EMA5 was initiated.
- 2006 – Upper Chinle collection wells CE5, CE6, CE11, and CE12 were added to Upper Chinle collection well CE2 in 2006. Upper Chinle collection well CW53 was added to the southern irrigation system.
- 2007 – Infiltration lines NPV7 and NPV8 were started to be injected during the year. The Lower Chinle well CW42 was added to the southern irrigation supply system.
- 2008 – The Middle Chinle well 493 was added to the southern irrigation supply system.
- 2009 – Upgradient alluvial wells P2, P3 and P4 were switched to a supply for the freshwater flushing of the large Tailings Pile
- 2010 – Evaporation Pond #3 (EP-3) was constructed and commissioned to increase the volume of water treated through evaporation.

1.2.2 Current Status of Site

HMC continues to remediate groundwater and control site access to the Grants site. Regulatory responsibilities are shared by NRC, EPA, NMED, and NMOSE. The NRC has oversight of the groundwater remediation and describes the site as being in the decommissioning phase. Groundwater remediation continues at this time, and final decommissioning will start after the completion of groundwater remediation.

EPA has recently completed sampling in support of a human health risk assessment (HHRA) for radon exposure, as well as use of groundwater to irrigate gardens of the nearby residences, and a report of the associated risks is expected in the fourth quarter of 2012. CERCLA required five-year reviews of the site continue, the most recent of which was released by EPA in September 2011. All reviews to date have determined that the current remedy is protective of human health and the environment.

The Large Tailings Pile, approximately 200 acres and 100 feet high, is currently capped with a radon barrier, has an erosion-protection cover on its sides, and has an interim soil cover on the top. A final radon barrier will be constructed after the tailings are flushed to the extent necessary to meet long term site closure objectives. The Small Tailings Pile is also capped with an interim soil cover. A final radon barrier will be placed once the groundwater restoration is complete.

Groundwater remediation consists of a groundwater collection/injection system for the San Mateo Alluvial aquifer and the Upper, Middle and Lower Chinle aquifers, tailings collection wells within the tailings impoundment, tailings impoundment toe drains, and RO treatment plant, as well as three evaporation and two collection / storage ponds.

1.3 Purpose of Report

As described above, the purpose of this report is to explore the costs, efforts, and requirements to be met under the alternatives of continuing with the current remediation and reclamation strategy or a hypothetical move of the tailings pile to a location outside of the San Andres Aquifer basin and the Village of Milan. With either alternative, on-site groundwater remediation would continue. For costing purposes, a distance of 30 miles was chosen for this evaluation because it would relocate the pile outside of the Village of Milan, outside of the San Andres Aquifer basin, and could potentially be in a location more distant from a population center and out of sight of the general public.

Costs for relocating the Large Tailings Pile are based both on site-specific considerations as well as using costs, labor, conceptual engineering designs, and risk estimates from the relocation of the Moab Tailings Pile. The Moab Tailings Pile is currently being moved approximately 30 miles from its present location.

The Moab Tailings Pile is approximately 16 million tons of tailings, compared to the HMC-Grants Site Large Tailings Pile volume of approximately 20 million tons. Unlike HMC-Grants, the Moab Tailings Pile relocation is overseen by DOE, is regulated as a Uranium Mill Tailings Radiation Control Act (UMTRCA) Title 1 Site, is not a Superfund Site, and is completely federally funded as the licensee is bankrupt.

1.4 Alternatives

The alternatives evaluated in this report are the current on-site remedy or a relocation of the Large Tailings Pile to an off-site location. Current groundwater remediation at the HMC-Grants Site is discussed in Sections 1.5 and 2.1 as this committed effort would need to be completed regardless of the final closure option for the Large Tailings Pile.

1.4.1 On-Site Remedy (Current Remediation)

As described in detail in Section 2, groundwater restoration commenced in 1977. The mill ceased operations in 1990 and was buried on-site. Under the on-site remedy alternative, groundwater remediation would continue until site closure standards have been achieved, consistent with the current CAP and NRC license. When groundwater remediation is deemed complete by the regulatory agencies, the RO plant, other buildings (if necessary), contaminated equipment, and contaminated piping will be demolished and placed in either Evaporation Pond #1 or #2 and permanently capped. Uncontaminated equipment and debris will be disposed of as appropriate.

1.4.2 Off-site Alternative

Under this alternative, the tailings of the Large Tailings Pile, radon cover, erosion cover, interim radon barrier, and any soil or other material in the Large Tailings Pile would be excavated and moved to a different location. For costing purpose, a hypothetical location approximately 30 miles from the current location was analyzed. Such a move could be accomplished via truck haul, rail haul, and/or slurry pipe. All three tailings relocation transportation options are discussed in the off-site alternative evaluation in Section 2.3.

Under the off-site remedy alternative, groundwater remediation would continue until site closure standards have been achieved, consistent with the current CAP and NRC license. When groundwater remediation is deemed complete by the regulatory agencies, the RO plant, other buildings (if necessary), contaminated equipment, and contaminated piping will be demolished and placed in either Evaporation Pond #1 or #2 and permanently capped. Uncontaminated equipment and debris will be disposed of as appropriate.

1.5 Groundwater Remediation

Groundwater remediation was started in the late 1970s upon discovery of elevated selenium levels and is currently on-going. The current groundwater remediation is described in Section 2.1 and consists of water treatment by various methods, as well as downgradient injection wells that reduce or impede future downgradient movement of the groundwater plume.

Under either the on-site or off-site alternatives, groundwater remediation would continue until remediation standards have been met. When groundwater remediation is complete and groundwater quality restoration is approved by the agencies, the site will be transferred to DOE for long-term site care and maintenance. Only at that point could an off-site relocation effort be undertaken. Groundwater remediation is required and therefore is considered a committed cost under both alternatives.

2.0 DESCRIPTION OF ALTERNATIVES

The following subsections describe the current site plan for remediation and closure of the Site (Section 2.2) after completion of the on-site groundwater remediation (Section 2.1); and the hypothetical alternative of relocation of the Large Tailings Pile (also with on-site groundwater remediation and eventual closure of the facility) (Section 2.3). The off-site alternative describes the steps that would need to be taken to identify a relocation site as well as the efforts associated with construction of a relocation facility.

Currently, groundwater is being remediated under a CAP first issued in 2001 and revised in 2006. The most recent CAP (HMC et al., 2012a) has been submitted to the NRC. The CAP is overseen by the NRC and is required of all NRC licensees as well as the provision of financial assurance and a mitigation plan to correct site environmental issues. The groundwater remediation, as described in Section 2.1, is not an alternative as it will continue until complete, and site reclamation will not begin until that time.

2.1 Groundwater Remediation

An annual monitoring report and performance review of groundwater treatment is produced by HMC for the NRC and NMED. Details of the groundwater treatment program can be found in the annual report. The draft 2012 CAP (HMC et al., 2012a), annual irrigation report (HMC et al 2012b) and 2012 Annual Monitoring Report (HMC et al., 2012c) are cited here, covering groundwater monitoring and treatment results through 2011.

Groundwater quality constituents of concern are uranium, selenium, molybdenum, total dissolved solids (TDS), sulfate, chloride, nitrate, radium, vanadium, and thorium. Table 2-1, below, presents the standards for each constituent and each aquifer as approved in License Amendment No. 30, with consultation with the State of New Mexico and EPA. Standards were set at background or drinking water standards, whichever was greater.

Table 2-1. Site Groundwater Standards

Constituent	Alluvial	Chinle Mixing Zone	Upper Chinle Non-Mixing Zone	Middle Chinle Non-Mixing Zone	Lower Chinle Non-Mixing Zone
Selenium (mg/L*)	0.32	0.14	0.06	0.07	0.32
Uranium (mg/L)	0.16	0.18	0.09	0.07	0.03
Molybdenum (mg/L)	0.10	0.10	0.10	0.10	0.10
Sulfate (mg/L)	1,500	1,750	914	857	2,000
Chloride (mg/L)	250	250	412	250	634
TDS (mg/L)	2,734	3,140	2,010	1,560	4,140
Nitrate (mg/L)	12	15	†	†	†
Vanadium (mg/L)	0.02	0.01	0.01	†	†
Thorium-230 (pCi/L**)	0.30	†	†	†	†
Ra-226+Ra-228 (pCi/L)	5	†	†	†	†

†Site standards not necessary for the constituents in the indicated aquifer.
*mg/L = milligrams per liter
**pCi/L = picocuries per liter

Groundwater restoration at HMC-Grants is comprised of two main components: reducing the contaminant source (the Large Tailings Pile) and reducing the lateral extent of the off-site contaminant plumes (decreasing the plume size and pulling the impacts back to within the Site boundaries). The on-site alternative would continue the program to reduce the contaminant loading to the groundwater system from the Large Tailings Pile. The program to reduce the lateral extent of the off-site contaminant plumes would continue even if the Large Tailings Pile were to be relocated.

Six methodologies for groundwater restoration are currently used at the HMC-Grants Site:

1. Passive and active evaporation
2. Freshwater injection to reverse the hydraulic gradient and cause a reduction in plume size
3. Tailings dewatering
4. Tailings flushing
5. RO treatment of extracted groundwater
6. Land application (irrigation)

Water recovered by the dewatering and flushing programs is routed to either an evaporation pond or the RO plant. By the end of 2011, 369 million gallons of water had been removed from the large tailings pile by dewatering wells (HMC et al., 2012c).

Currently, three evaporation ponds are in use: the east pond (EP1), the west pond (EP2), and the north pond (EP3). The smaller east and west collection ponds have been operational since October 1986 for waste water management but are not considered as material for evaporative water management efforts at the Grants Site. The EP-1 pond is located on the Small Tailings Pile and began receiving water in November 1990. Usage of the EP-2 pond began in March 1996. Construction of the third pond (EP-3) was completed by the fourth quarter of 2010 and it was put to immediate use.

Over four billion gallons of contaminated groundwater have been recovered by the collection wells, tailings wells, and the toe drains since 1977. Over 1.1 million pounds (503,003 kg) of uranium have been removed from groundwater, toe drains, and tailings pile collection wells from 1978 through 2011. About 63,828 pounds (28,952 kg) of selenium and 1,514,166 pounds (686,814 kg) of molybdenum have been removed during the same time period (HMC et al., 2012c).

2.1.1.1 Freshwater Injection

Freshwater injection has been used at the site since 1977 to control the hydraulic gradient near the tailings pile and contain water impacts to within the Site boundaries. Water from the San Andres Aquifer is pumped and re-injected to wells along the south, east, and west site boundaries. This practice began in 1977 and was continued through the remaining operational phase of the mill. It continues to this day, with the freshwater supply supplemented by water that has been treated in the RO plant and has helped successfully reduce the size of the plume (HMC et al., 2012c).

2.1.1.2 Tailings Dewatering

Starting in 1995, use of tailings dewatering wells was initiated to hasten the draindown of water in the Large Tailings Pile. Wells were installed and pumps used to extract water from the tailings pile, which was then placed in the evaporation ponds.

2.1.1.3 Large Tailings Pile Flushing Program

The Large Tailings Pile flushing program was initiated in 2003, in conjunction with the tailings dewatering program. The Large Tailings Pile is in close proximity to the neighboring residential subdivisions; therefore, the point of exposure wells are very close to the Large Tailings Pile. The HMC-Grants Site implemented the flushing program to reduce long-term residual flux and to accelerate the removal of uranium-laden tailings water, which is directed to the RO plant or the evaporation ponds. From 2002 to 2009, almost 80,000 kg of uranium was removed from water flushed through the tailings pile (HMC et al., 2012a).

A tracer/rebound study in the Large Tailings Pile was initiated in early 2011 to evaluate the stability in uranium concentrations in tailings water upon completion of the flushing program. A well network in a two-acre portion of the Large Tailings Pile was isolated and a dissolved gas tracer (SF6) was continuously applied over a three-month period in order to understand the rate of water movement through the Large Tailings Pile in that area. The water chemistry of the 10 evaluation area wells is monitored on a monthly basis and results of the tracer study will be used to determine the significance of rebound potential upon completion of the tailings flushing.

2.1.1.4 Reverse Osmosis

Starting in 1999, a 300-gpm low-pressure RO system and a high-pressure RO system were constructed on the HMC-Grants site. In 2001, an additional 300 gpm low-pressure RO system was completed.

Water is pumped from the alluvial aquifer or collected from the Large Tailings Pile recovery wells. Before water is fed to the low-pressure RO units, it is treated in a solids contact clarifier (SCC) to remove calcium from the water. Overflow from the SCC is sent to a set of four parallel sand filters. After being treated in the SCC or sand filters, the water is dosed with sulfuric acid to reduce the pH to nearly 7. Prior to being fed to the RO pressure vessels, the water is pumped through 5-micron string filters.

Contaminants are removed from the water by RO in the membrane/pressure vessels. The membranes are typically replaced on an annual basis, but are cleaned more frequently.

2.1.1.5 Land Application

The land application of water involves low-concentration water from the wells downgradient of the freshwater infiltration trenches. From 2000 through 2009 the downgradient water from the multiple recovery wells was blended to contain less than 0.44 mg/L of uranium, and then applied to four agricultural fields to grow hay used for animal feed. Since 2009, the system has been operated at a significantly reduced rate coupled with a "blend-down" of uranium levels in the water prior to land irrigation and alternate technologies are being evaluated to replace land application.

The irrigated fields are located in Sections 28, 33, and 34 in Township 12 North, Range 10 West and are owned by HMC. Figure 1-2 shows the locations of the fields, which are irrigated either by center pivot or flood irrigation systems. The total amount of irrigation water applied to the fields from 2000 to 2010 was 9,241 acre-feet, ranging from 201 to 1,058 acre-feet annually (HMC et al., 2012b).

An annual report assessing irrigation water concentration and impacts to soil, groundwater, vegetation, and public exposure impacts of the land application has been produced since 2000.

Details of the land application and its potential impacts can be found in *Grants Reclamation Project Evaluation of Years 2000 through 2011, Irrigation with Alluvial Groundwater* (HMC et al., 2012b). In summary, the report finds all impacts are minimal and within acceptable levels of risk, exposure, uranium and selenium retention in soil, or uptake through animal feed. NMED also continues to evaluate the potential impacts of land application of the irrigation water and the appropriateness of continuing to use this technology for groundwater treatment.

2.1.1.6 Radon Control

The Large Tailings Pile currently has a radon barrier and erosion protection cover on the side walls. There is an interim cover on top to prevent particulate dispersion and diminish radon emissions. The portion of the Small Tailings Pile that is not covered by Evaporation Pond #1 also has an interim cover on the top. In 1995, the mill was demolished and buried on site; this area also has a radon barrier and erosion protection cover in place.

The current air monitoring program includes particulate and radon sampling (see Figure 2-1). Annual air monitoring is conducted to ensure compliance with regulatory requirements of 10 CFR 40 and 10 CFR 20 regarding exposure of members of the public and occupational dose limits from licensed activities at an NRC-licensed facility. The air monitoring program is based on NRC Regulatory Guidance (RG) 4.14 Revision 1 (NRC, 1980). In addition, radon flux from both tailings piles is monitored on an annual basis. Radon sampling and dose assessments have been conducted as part of the evaluation of land irrigation as well.

Occupational exposure to radiological materials is monitored through bioassay and badging programs, as well as mandatory training of all employees.

2.2 On-Site Alternative

The on-site remedy includes the remedial action currently underway for groundwater, with subsequent removal of the RO plant and associated systems, and final cap and closure of the Large Tailings Pile, Small Tailings Pile, and evaporation ponds.

2.2.1 Site Reclamation

Final physical reclamation and closure of the Large Tailings Pile will occur after completion of the ongoing pile flushing program and completion of residual extractive pumping of water remaining in the pile, prior to natural drain down. The activities will include final work on the radon barrier and erosion rock cover on the Large Tailings Pile. Final closure of the Small Tailings Pile will occur subsequent to the closure of the evaporation ponds. The RO plant will be decommissioned, demolished, and removed along with contaminated plant, equipment, and piping systems. At this time, it is planned that the demolished and contaminated equipment and buildings will be placed in Evaporation Pond #1 or #2, which will necessarily be after groundwater remediation is complete. Uncontaminated materials may be entombed on-site or disposed of off-site as deemed appropriate. Definitive plans will be developed as groundwater remediation nears completion. Final closure of the site is expected to be complete within two years after regulatory agency approval of the completion of the groundwater remediation.

2.2.2 Applicable Regulations

The site currently operates under NRC License SUA-1471, with EPA oversight provided through a MOU between the NRC and EPA. As a Superfund site, CERCLA regulations and requirements must be met. Worker exposure is also monitored.

State permits are also held for the Site, and state regulations as well as permit conditions are adhered to. A complete list of permits and regulations for HMC-Grants is provided in the 2012 Updated Corrective Action Program document (HMC et al., 2012a), including federal regulations such as CERCLA, Resource Conservation and Recovery Act (RCRA), Safe Drinking Water Act (SDWA) and state regulations such as the New Mexico Water Quality Act, New Mexico Air Quality Control Act, and New Mexico Hazardous Waste Act.

Closure plans will be submitted and approved through the NRC and EPA, as well as state agencies. All plans will follow regulatory guidance to provide complete closure that is protective of human health and the environment. DOE will have long term legacy management responsibility for the site and will continue monitoring groundwater and site conditions.

2.2.3 Monitoring and Maintenance

Monitoring of the HMC-Grants Site is comprised of groundwater, air/weather, radiation, and settlement of the Large Tailings Pile. The monitoring programs are part of a comprehensive surveillance and reporting system necessary to monitor remediation, identify issues or concerns, and to provide required reporting and information sharing with the regulatory agencies, as well as meeting permit requirements and responsibilities. The information collected in the monitoring programs is used to produce reports as required by permit or regulatory authority.

Groundwater monitoring, as described previously, has been conducted since 1977 and encompasses a large network of monitoring wells, extraction wells, and collection wells. The monitoring program would continue at current rates until final site closure, when the site will be deeded to DOE for long-term care and maintenance with an established groundwater monitoring schedule consistent with that purpose.

Air monitoring for particulates and radon occurs at several locations. As described in the 2011 Semi-Annual Monitoring Report (HMC, 2012), HMC continuously samples total suspended particulate at six locations around the reclamation site (see Figure 2-1). Monitoring locations HMC-1, HMC-1A, HMC-2, and HMC-3 are areas at the property boundary expected to have the highest predictable concentrations of airborne radioactive particulate. HMC-1A was added to the environmental monitoring network as a part of the commissioning of a new evaporation pond, EP-3, which was constructed in 2010. The predominant wind direction is from the southwest; accordingly, HMC-1, HMC-1A, HMC-2, and HMC-3 are generally located downwind from HMC-Grants' reclamation activities.

Monitoring location HMC-6 represents background conditions and is located due west of the Large Tailings Pile at the western most side of the property boundary. Monitoring locations HMC-4 and HMC-5 are near the site perimeter, but proximal to the nearest residences. Energy Laboratories, Inc. analyzes the collected samples quarterly for natural uranium, radium-226, and thorium-230.

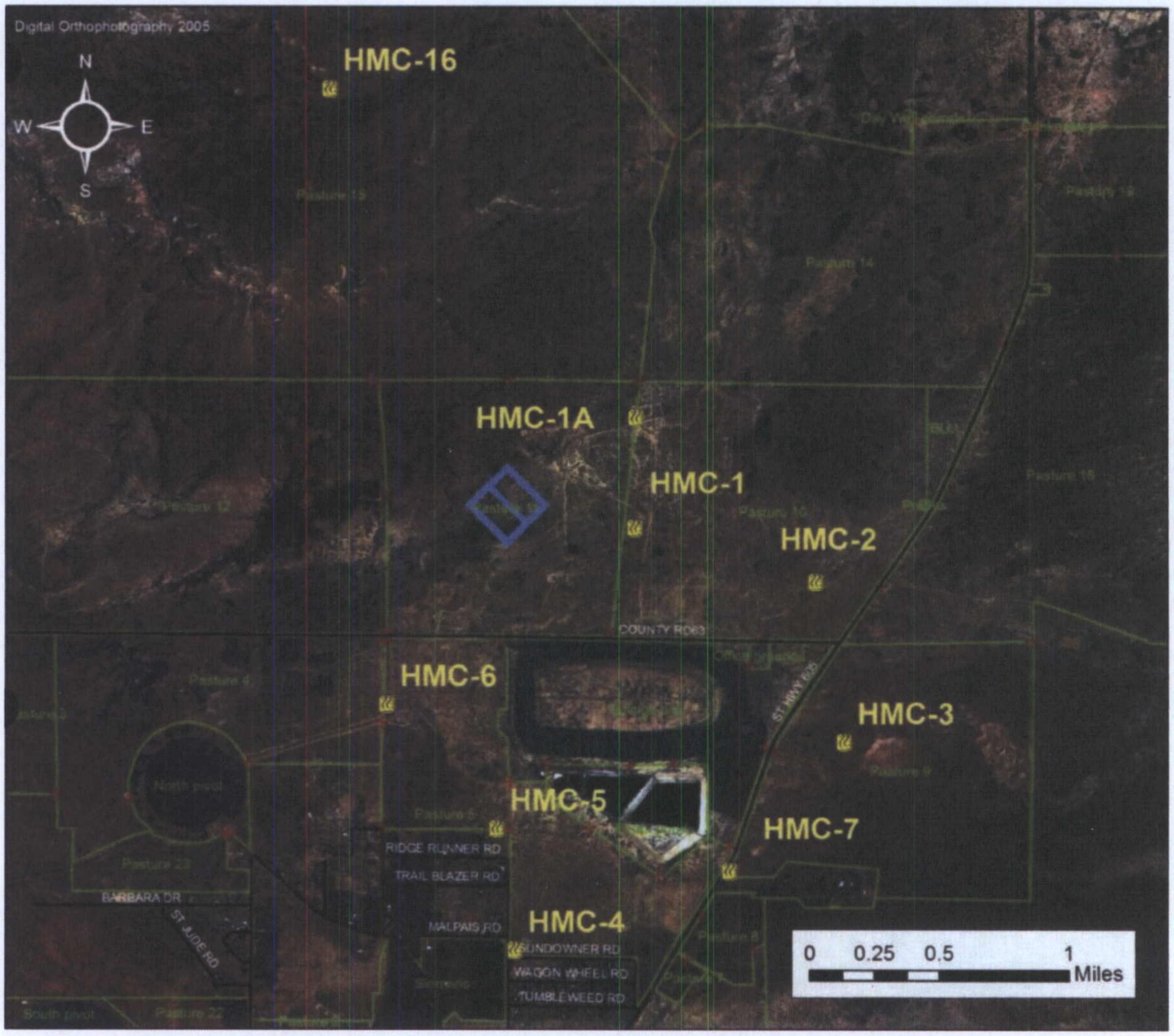
Radon gas concentrations are monitored on a continuous basis at the nine locations identified in Figure 2-1. The background station for radon gas is HMC-16, located northwest of the site. Landauer Corporation track-etch passive radon monitors (PRM), or the equivalent, are used to continuously monitor radon gas at each sampling location. The detectors are retrieved on a quarterly basis (HMC, 2012).

Gamma exposure rates are continuously monitored through the use of optically stimulated luminescence (OSL) dosimeter badges placed at seven site locations and one background location identified in Figure 2-1. HMC-16 is considered the background location for direct radiation. The OSLs are exchanged semi-annually and analyzed by an approved independent laboratory. The levels of direct environmental radiation are recorded for each of the locations (HMC, 2012).

Radiation monitoring of on-site personnel is conducted through a bioassay and badging program.

Settlement monitoring of the Large Tailings Pile is conducted as provided by permit and continues on an annual survey basis.

Monitoring will continue after site closure to ensure the remedy is effective and all barriers are maintained. It will likely include several of the monitoring components currently in place.



Location ID	Sampling Unit	Northing	Easting
HMC1	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1547458.8	491370.5
HMC1A	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1549715.8	491387.7
HMC2	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1546349.5	495053.2
HMC3	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1543048.7	495640.5
HMC4	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1538751.1	488918.0
HMC5	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1541268.4	488546.3
HMC6	Hi-Vol Particulate (Air), Track-Etch Cup (Radon), OSL Badge (Gamma)	1543813.1	486297.3
HMC7	Track-Etch Cup (Radon)	1540395.7	493293.8
HMC16 (BKG)	Track-Etch Cup (Radon), OSL Badge (Gamma)	1556470.5	485135.1

- Location
- Road
- Gate
- EP-3
- Fence Line
- Section Line

Figure 2-1
HMC Air Monitoring and Sampling Locations

2.2.4 Resource Requirements

The following subsections discuss the resource requirements of the current operations and on-site reclamation alternative. As accepted by the NRC in December 2011 (NRC, 2011), the estimated cost to complete the reclamation (2012 to 2017) was estimated at $41,093,194. Table 2-2 shows a further detail of the estimated budget. Costs listed under "Long-term Care and Maintenance" would be required under either on- or off-site alternatives. A large portion of the Physical Reclamation Costs would also be required, as this cost includes demolition and final closure of the evaporation ponds, RO plant, and associated infrastructure.

Table 2-2. Summary of Cost to Complete, 2012-2017 (as approved by NRC, 2011)

Project	Cost ($)	Totals ($)
Physical Reclamation		
Tailings Facility Closure/Reclamation	14,280,695	
Other On-Site Demolition	186,771	
Subtotal		*14,467,467*
Long-term Care and Maintenance		
Water Treatment	12,470,001	
Monitoring/Regulatory	1,801,953	
Holding	276,000	
Security/Maintenance	24,000	
General and Administrative	5,983,486	
Subtotal		*20,555,440*
Subtotal (Physical Reclamation and Long-term Care and Maintenance)		35,022,907
15% Contingency		5,253,436
NRC Long-term Maintenance/Surveillance Fee		816,851
TOTAL		**41,093,194**

It should be noted that an update to the CAP for the Grants site is presently under review by NRC and other site regulatory agencies. Groundwater remediation completion dates, final physical site closure date, and associated estimated budgets may change based on the review and approval of the revised CAP.

2.2.4.1 Labor

Both HMC employees and contractors are used to meet the workload and project demands of the Site. HMC employee costs are included in the General and Administrative cost estimate. Cost for contractors is contained in the subcategories for Physical Reclamation Costs and Long-term Care and Maintenance.

2.2.4.2 Equipment

Equipment at the Site includes the RO plant, trucks, backhoe, front end loader, fork lift, mobile generator sets, pipe fusion machines, and pumps, among other equipment. Groundwater wells and monitoring equipment are present at the Site as well.

Closure and demolition of the RO plant will involve contractor-supplied equipment.

2.2.4.3 Land Disturbance

Current land disturbance is minimal and associated only with maintenance or installation of wells or other remediation equipment. At Site closure, land disturbance will occur as on-site facilities are demolished and a final cover is placed on the Large Tailings Pile and the portion of the Small Tailings Pile requiring a final cover. In addition, erosion protection covers will be placed as needed.

2.2.4.4 Fuel

Fuel is used as needed for the Site equipment. Fuel costs are provided for in the water treatment budget, with approximately twice as much gasoline as diesel fuel being used annually. Fuel costs are currently estimated at over $22,300 per year for the remainder of the project; this value could change based on fuel costs.

2.2.4.5 Water

There is no potable water supply at the Site. Industrial water is pumped on-site for non-drinking purposes and drinking water is supplied through bottled water. Other water uses at the Site are tied to the groundwater remediation and treatment, including water injection wells, land application, and passive and active evaporation of extracted groundwater. These uses are controlled by permit and will continue until groundwater reclamation is complete.

Other uses of water at the Site include dust suppression as needed, and such use will increase at final closure with plant demolition and placement of final covers.

2.2.4.6 Solid Waste Disposal

Solid waste disposal is minimal and is handled by municipal facilities. Solid waste disposal will increase when closure commences due to the greater number of workers that will be needed, but should not exceed municipal capacity.

2.2.4.7 Sanitary Waste Disposal

Sanitary waste disposal is provided by septic system at the site. Capacity would be exceeded for the workforce anticipated for the off-site alternative and would require additional septic systems. Current capacity is expected to be sufficient for the on-site closure alternative.

2.2.4.8 Electric Power

Electric power is used for the RO plant and associated systems, the central pivot and flood irrigation systems, administrative offices, and maintenance facility and will continue through Site closure. Costs for electric power are contained within the estimates provided for the various subcategories of long-term care and maintenance. Electric power use will not change until project closure, as it is integral to groundwater remediation technologies. At closure, electric power use will significantly decrease.

2.2.5 Current Human Health Risks

Current on-site exposure to humans is limited to those employed by HMC and those granted access to the Site. Exposure to the public at the HMC-Grants Site is minimal as the Large Tailings Pile, evaporation ponds, RO plant, and associated buildings are within a radiological restriction area. The restricted area of the Site is fenced and HMC personnel are present on the

Site. Unauthorized access is unlikely to occur and there is no recreational use of the land or its immediate surroundings, and a surveillance security system is in place. In addition, HMC owns a sizeable portion of land around the reclamation area. As stated in the 2011 Annual Report (HMC et al., 2012c):

> *Over the last number of years, additional lands have been acquired as opportunity has arisen and acquisition of such lands are deemed appropriate in relation to ongoing groundwater remediation and restoration activities and final reclamation /closure of the site.*

Low-density neighborhoods are located to the south and southwest of the Site and are the nearest off-site potential receptors. The east side of the property is bounded by Highway 605.

Per the land use survey provided in Appendix E of the 2011 Annual Report (HMC et al., 2012c):

> *Much of the HMC lands held in the area that are not in immediate proximity to the tailings pile complex have been, and are continuing to be, utilized for livestock grazing on a lessor/lessee tenant arrangement. Most of the current land area within the immediate Site Boundary area containing the evaporation ponds, RO plant and both tailings pile areas and office / shop compound have been excluded from livestock grazing and other land use except those directly related to the ongoing ground-water restoration activities. These areas have been livestock fenced to exclude grazing; certain small areas in the southern and western portions of land within the Site Boundary are, however, seasonally utilized for livestock grazing.*
>
> *Several small lot / small acreage parcels [e.g. residential lot(s)] held by HMC in the general area of the reclamation site are idle and are essentially not in use except in certain instances where fresh water injection and water collection is underway as part of the ongoing groundwater restoration program or are under agricultural use on selected lot (s). For example, Block 1 Lot 5 and Block 2 Lot 2 in Murray Acres were planted and irrigated in 2008 through 2011.*
>
> *The other significant land use activity situated on HMC-held lands in the area includes land treatment / crop irrigation utilized for crop production. Water used for irrigation is an integral part of the ongoing ground-water restoration and cleanup program for the project. Prior to 2002, HMC had 270 acres of land under irrigation consisting of flood irrigation area comprising 120 acres and a center pivot spray irrigation area comprising 150 acres. During 2002, an additional center pivot irrigation system was commissioned that comprises 60 acres. In 2003, an additional 24 acres of flood irrigation was added to the irrigation system in Section 33. In 2005, the 60 acre center pivot irrigation system was expanded by 40 acres to a total of 100 acres.*

For 2011, HMC lands that were under crop irrigation totaled 100 acres in one field situated in Section 28. The remaining 294 acres in the other three farm fields were not irrigated during 2011.

The potential risks to human health from groundwater, radon, and airborne particulates have been assessed by EPA and HMC at different times during the reclamation project, and an annual assessment of risks associated with the irrigation fields is conducted. EPA has reported on potential human health risks at each five-year review of the Site. HMC has included a human health risk assessment in its annual irrigation reports to assess potential future exposure at the irrigated fields and with the use of hay from the irrigated fields as feed for cattle, with subsequent human ingestion of beef. In addition, ATSDR performed a public health evaluation at the request of EPA.

As stated by EPA in their second five-year review (EPA, 2006):

> *The remedy being implemented at the Site is considered protective of human health and the environment in the short term; some further action is necessary to ensure continued protection of human health and the environment in the long term. Currently, exposure pathways, through consumption of impacted ground water that could result in unacceptable risk are being controlled. The reclamation and remediation activities performed to date are restricting emissions of radiological constituents and monitoring is in place to ensure that U.S. Nuclear Regulatory Commission (NRC) standards are being met during the ongoing remedial activities. Ground water remediation is ongoing, and expansion and improvements have been made to the ground water restoration program since the completion of the first five-year review in 2001.*

In November 2005, EPA requested that the ATSDR conduct a public health evaluation for the Site with the results of a well survey from 34 off-site private wells. EPA and NMED conducted additional sampling in 2006 and 2007 and found that some residents had groundwater with uranium and selenium above Maximum Contaminant Levels (MCL) and a few were using their private wells as drinking water. ATSDR recommended that owners using wells in the alluvial and Chinle aquifers as a source of drinking water obtain another source of potable water (such as the city-supplied water) although ATSDR calculations indicated that those wells being used as a source of potable water did not contain contaminants at levels that would produce known health effects. Therefore, the ATSDR categorized groundwater in private wells as a "no apparent public health hazard," defined as those sites where exposure to Site-related chemicals might have occurred in the past or is still occurring, but the exposures are not at levels likely to cause adverse health effects (ATSDR, 2009).

Since 2006, HMC paid for additional residential properties to be connected to the Village of Milan water system and NMED issued a health advisory to minimize the possibility of new wells being installed in the area. Residents still have the option to use groundwater for irrigation purposes or for watering livestock.

In addition, EPA's second five-year review noted that the Site is well-maintained and remedial actions performed at the Site have reduced contaminant levels on site as well as reducing plume size. No deficiencies were noted that impacted the current protectiveness of the remedy. Nonetheless, EPA stated in their third five-year review that even though the Record of Decision called for no further action as regards the off-site exposures, in September 2010, EPA began collecting sampling data to support the development of a human health risk assessment for indoor and outdoor radon exposure. The report is expected in the fourth quarter of 2012, but a preliminary account of the data was presented by EPA in a community meeting on March 8, 2012. The sampling results showed that no outdoor radon levels exceeded 3 pCi/L at any of the residences to the south-southwest of the Site. Indoor radon levels were measured as well. Nine of the 81 sampled homes had indoor air radon in excess of 4 pCi/L (the EPA action level), compared to two of 31 background homes; the maximum concentration was 17.16 pCi/L (EPA, 2012a). However, these homes were furthest from the Large Tailings Pile, and the source of the indoor radon is unclear. EPA is currently conducting a program to abate indoor radon levels in these nine residences.

EPA reports that the air monitoring results currently meet the NRC's dose equivalent criterion, and EPA's measured concentrations of radon in outdoor air are below 4 pCi/L (EPA's level of concern for indoor air).

HMC produces an annual report regarding risks associated with the land application of water. In the most recent, produced from 2011 data (HMC et al., 2012b), potential radiation doses to the public were evaluate for the exposure pathways and scenarios of:

- Residents eating beef fed with hay from the irrigated area,
- A hypothetical resident farmer living on and farming the Section 34 irrigated area, and
- Current residents living near the irrigated areas during and following cessation of crop irrigation activities.

The results of the analysis for each scenario showed that the radiological dose received by existing off-site occupants and hypothetical future on-site residents is "extremely small (less than 1 percent) compared to the average dose that the population receives from natural background and medical exposures" (HMC et al., 2012b). Specifically, the report notes that uranium is being retained in the upper layers of treated soil. The dose to humans from eating beef fed the hay grown on the irrigated lands is 0.02 millirem per year (mrem/year), compared to the average dose to the U.S. population of more than 600 mrem/year from natural background, manmade, and medical exposures. The dose to a hypothetical resident farmer (living and farming on the previously irrigated land) was estimated using RESRAD Model, version 6.4, and current measured concentrations of radionuclides in soil (data from Section 34, the irrigated area having the highest net uranium concentrations). Using the exposure concentration of 2.31 pCi/g above background, RESRAD predicts individual path and total committed doses at one, three, 10, 30, 100, 300, and 1,000 years in the future. The predicted dose rate for the first few hundred years was approximately 0.5 mrem/year with a maximum of 6.8 mrem/year, occurring after 1,000 years. Again, the dose is insignificant compared to the average radiation dose from natural background, manmade, and medical sources and is comparable to the average radiation dose to the public from cooking with natural gas (HMC et al., 2012b).

In addition, release of radon-222 from water being sprayed to irrigate the fields was evaluated to determine potential risks to existing nearby residents. A detailed evaluation had been prepared in 2009 and concluded that the potential risk from such an exposure was 1.1×10^{-10}, a negligible level. As Site conditions, water concentrations, radon concentrations, and exposure had not changed since 2009, the risk evaluation for this pathway was not conducted again in 2010 (HMC et al., 2012b).

Finally, dose from potential exposure to nearby residents of airborne natural uranium contained in dust from the irrigation areas was evaluated. Calculations using the soil concentration of 2.31 pCi/g above background resulted in an upper-bound exposure estimate of 0.79 mrem/year (HMC et al., 2012b).

2.3 Off-Site Alterative

This section identifies the steps that would need to be taken to both identify a relocation site for the Large Tailings Pile and to construct a permanent off-site disposal cell. The off-site disposal alternative would involve excavating and relocating the entire Large Tailings Pile at the HMC-

Grants Site to the permanent off-site disposal cell location. The excavated material from the Large Tailings Pile would be transported via rail, truck, or slurry pipeline. The off-site disposal alternatives assume that the existing Site infrastructure and any on-site contaminated material would be placed into the lined evaporation ponds and reclaimed as described in Section 2.2. Groundwater treatment at the HMC-Grants Site would continue even if the Large Tailings Pile were to be relocated as discussed in Section 2.1. Additional steps required in the off-site disposal alternative include siting studies, new siting permitting, evaluation of alternatives, identification and selection of an off-site disposal cell location, general resourcing requirements, and construction of the disposal cell.

The off-site disposal alternative for the HMC-Grants site is a hypothetical alternative and no specific location for relocation has been identified as part of this evaluation. Identifying such a location could be difficult based on siting criteria, environmental considerations, land ownership, regulatory requirements, and public acceptance. However, for the costing purposes of this report, the evaluation of the off-site disposal effort assumes that the proposed off-site disposal location would be located 30 miles from the HMC-Grants Site. Prior to identification of a permanent disposal location, a variety of alternative disposal cell locations would need to be studied and evaluated.

Figure 2-2 shows the geographic location of the Site and general topographic features in the area. The hypothetical 30-mile radius used for costing purposes has been overlain on the figure. The primary efforts and actions associated with implementing the off-site disposal alternative include the following:

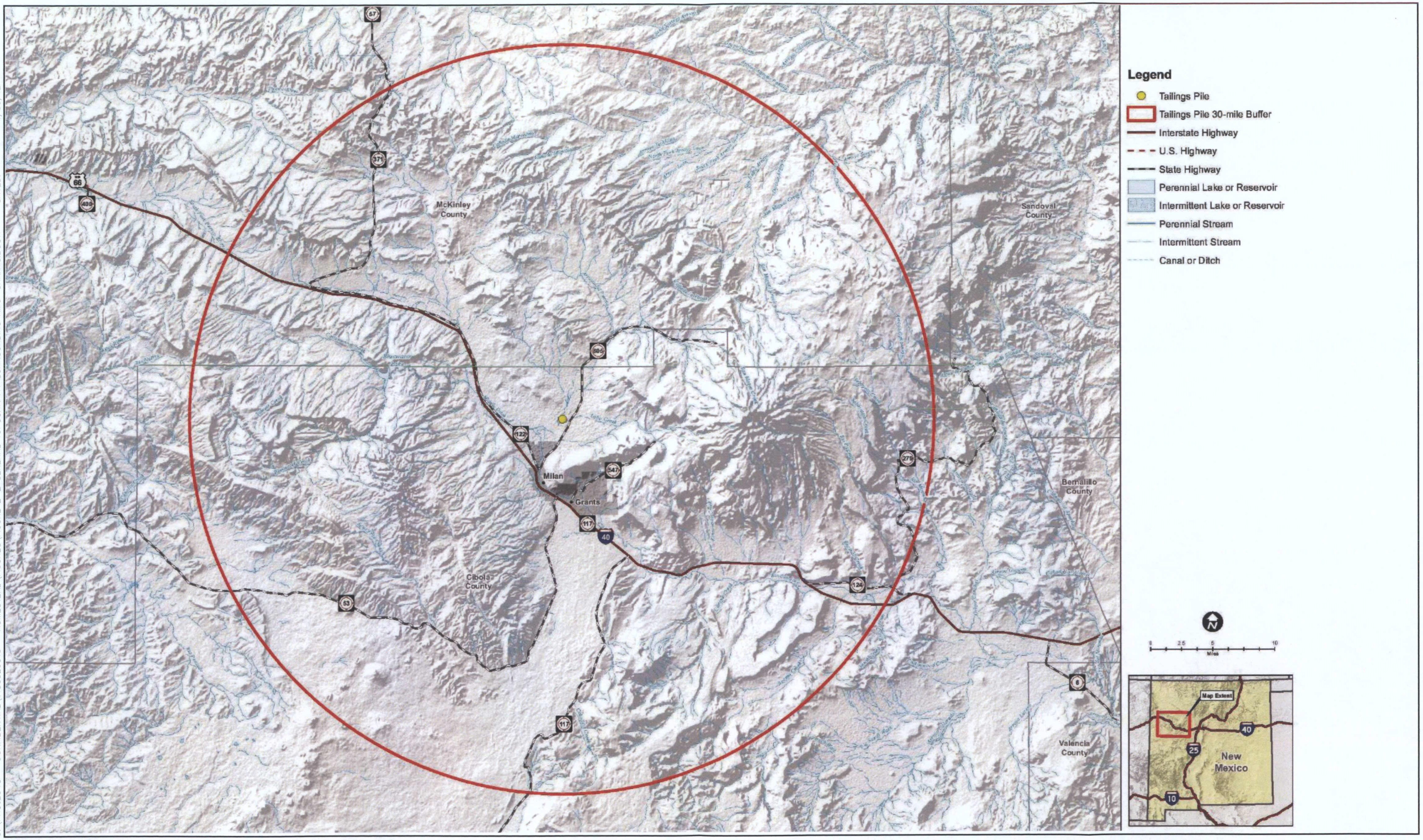
- Site identification, new siting studies, siting permitting, and public meetings (Section 2.3.1).
- Construction and operations at the permanent off-site disposal location (Section 2.3.2).
- Transportation of contaminated material from the HMC-Grants Site to the off-site disposal location (Section 2.3.4).
- Monitoring and maintenance of the off-site disposal location (Section 2.3.6).
- Long-term stabilization, surface reclamation, and site closure of both the HMC-Grants Site and relocation site (Section 2.3.2.3).

Resource requirements for the off-site disposal alternative including: labor, equipment, fuel, water, land disturbance, electric power, sanitary waste disposal, and solid waste disposal. These requirements are discussed in Section 2.3.7.

2.3.1 Siting

This subsection describes the siting process for the off-site disposal alternative. After identifying potential alternative off-site disposal locations, new siting studies will be required.

The National Environmental Policy Act (NEPA) requires an environmental impact statement (EIS) for certain actions significantly affecting the quality of the environment. The excavation and relocation of the 20 million tons of radioactive tailings from the Large Tailings Pile plus the cover soils and impacted soil beneath the pile at the HMC-Grants Site would be considered an action that has the potential to significantly affect the quality of environment and human health.



Project No. 1159520013

April 2012

Figure 2-2
General Topography Surrounding HMC-Grants

To fulfill the NEPA requirement of considering a full range of alternatives, an EIS would be required to evaluate the environmental consequences that would result from each of the alternatives, including health impacts to the public, impacts to ecology, impacts to groundwater and surface water, traffic impacts, and impacts to any other resources including cultural and historical resources. Additionally, the EIS would analyze the no action alternative. For each of the proposed alternative actions, human health risks from radiation would be analyzed and compared in the EIS. If an off-site disposal alternative were to be selected, the EIS process would serve as a tool for identifying a suitable permanent off-site disposal location. After sufficient review, a final EIS (FEIS) will be written, and the proposed action will be announced.

Prior to implementing the off-site disposal alternative, a Remedial Action Plan would be designed that presents the basis for construction of a permanent off-site disposal cell at the designated location. The following studies and documents would need to be developed prior to off-site disposal selection:

1. Preliminary Plan for Remediation
2. Site Observational Work Plan
3. Draft EIS
4. Final EIS
5. Record of Decision
6. Remedial Action Plan
7. Completion Report
8. Long-Term Surveillance and Maintenance Plan (LTS&M)

The HMC-Grants Site is subject to CERCLA as a regulated Superfund site by EPA Region 6. Additionally, the HMC-Grants Site is a Title II site under Uranium Mill Tailings Radiation Control Act (UMTRCA) and operates under NRC license SUA-1471. Currently, HMC is responsible for clean-up of HMC-Grants and is operating under an NRC-approved reclamation plan. Partial surface reclamation has occurred under the approved reclamation plan, and final surface stabilization will occur after groundwater remediation is complete.

The off-site disposal alternative would require that existing permits are modified as necessary, and that new permits be obtained, where applicable. A variety of federal, state, local, and tribal permits may be required if the off-site disposal alternative is selected. Table 2-3 provides a list of environmental laws and regulatory acts that may be applicable for an off-site disposal alternative.

Table 2-3. Potentially Applicable Environmental Laws and Regulatory Programs

Act/Regulation	Reference
Atomic Energy Act of 1954	42 United States Code [U.S.C.] 2011
Wildlife and Fisheries	50 CFR 36.39
CERCLA	42 U.S.C. 9620, 40 CFR 300
Clean Water Act	33 U.S.C. 1251 et seq., 40 CFR 330 Appendix A
Resource Conservation and Recovery Act (RCRA)	42 U.S.C. 6901 et seq., 40 CFR 262 subparts A–C
Wilderness Management Act	16 U.S.C. 1131
Endangered Species Act	16 U.S.C. 1531–1534
National Historic Preservation Act	16 U.S.C. 470, 36 CFR 63, 36 CFR 800
National Environmental Policy Act (NEPA)	
UMTRCA	
U.S. Nuclear Regulatory Commission Regulation	

Act/Regulation	Reference
(NUREG) 1620-Standard Review Plan	
Environmental Protection, General	*New Mexico Administrative Code:* Title 20, Chapter 1
Air Quality	*New Mexico Administrative Code:* Title 20, Chapter 2
Radiation Protection	*New Mexico Administrative Code:* Title 20, Chapter 3
Hazardous Waste	*New Mexico Administrative Code:* Title 20, Chapter 4
Petroleum Storage Tanks	*New Mexico Administrative Code:* Title 20, Chapter 5
Water Quality	*New Mexico Administrative Code:* Title 20, Chapter 6
Solid Waste	*New Mexico Administrative Code:* Title 20, Chapter 9
Licensing Requirements for Land Disposal of Radioactive Waste	*New Mexico Administrative Code:* Title 20, Chapter 3, Part 13

A new general license would be required for the custody and long-term care, including monitoring, maintenance, and emergency measures necessary to protect public health and safety, for the new disposal cell location. The NMED Radiation Control Bureau New Mexico Administrative Code (NMAC) 20.3.3.306 Part B states the shipment and transportation of radioactive material shall be in accordance with the provisions of 10 CFR 71 "Packaging and Transportation of Radioactive Material." Prior to transportation of radioactive wastes from the HMC-Grants Site, a general license or specific license must be authorized to deliver licensed material to a carrier for transport or transport licensed material.

Potential off-site disposal cell locations could be located in either Cibola County or McKinley County, and both counties fall within the NMED Solid Waste Bureau Enforcement Area V. However, the HMC-Grants Site may be exempt from state licensing requirements for land disposal of radioactive waste if the off-site disposal alternative is selected and a new or revised general license is granted by the NRC.

The NMED Air Quality Bureau requires any owner or operator intending to construct a new stationary source which has potential emission rate greater than 10 tons per year of any regulated contaminant to file a notice of intent (NOI) with the department, which must be approved prior to constructing the source. Movement of the tailings would require an evaluation of the potential emission rate to determine if an NOI must be filed.

Additional federal, state, and local licensing requirements would be required if the off-site disposal alternative were selected. The nature and extent of the licenses would depend on the transportation method used for the tailings, the location of the disposal cell, the transportation route, and project needs for resources, at a minimum.

2.3.2 Construction and Operations at the Off-Site Disposal Cell Location

This subsection describes the construction and operations at the HMC-Grants Site and the new disposal cell location. This subsection discusses three primary elements including: (1) site preparation, infrastructure enhancement, and controls; (2) excavation and processing of tailings; and (3) the HMC-Grants Site reclamation. The design and specifications proposed for the alternative final placement location may vary significantly due to restrictions or resources at that location.

2.3.2.1 Site Preparation, Infrastructure Enhancement, and Controls

Many aspects of the off-site disposal alternative would be similar to those established at the HMC-Grants Site. The major differences are related to transportation infrastructure and access roads.

1. *Stormwater Management Controls*

Stormwater management controls are regulated under the NMED Surface Water Quality Bureau's National Pollutant Discharge Elimination System (NPDES) Stormwater Permit Program as established in Section 402 of the federal Clean Water Act (CWA). As with the on-site alterative, a stormwater pollution prevention plan (SWPP) would be prepared that complies with the NPDES industrial stormwater permit issued by the NMED. A stormwater management system would be implemented at the new off-site disposal location to prevent water, sediments, soils, and materials from the Site from entering any surface waters. The type of stormwater management controls will depend on the existing hydrologic conditions at the permanent off-site disposal location.

2. *Access Roads*

The traffic density would increase significantly for the off-site disposal method, requiring the construction of new access roads at the HMC-Grants Site. New access roads would also be required at the permanent off-site disposal cell.

3. *Radiological Controls*

Radiological controls would need to be implemented at the off-site disposal location to minimize potential for personnel contamination and the spread of radioactive materials. Personnel screening and decontamination procedures would be similar as at the HMC-Grants Site, but would include a much larger number of personnel and contractors during relocation activities. Radiological controls would be established for train/truck transfer stations. Contamination control fencing would need to be constructed to separate and secure any areas of contamination related to transport and disposal site activities.

4. *Temporary Field Offices*

The temporary field offices at the off-site disposal cell would need to be constructed prior to initiation of the disposal cell construction and operations.

5. *Staging and Vehicle Maintenance Areas/Fueling Area*

A staging area and vehicle maintenance area would need to be constructed at the off-site disposal location. Fuel storage tanks would be located at the off-site disposal location. The amount and size of fuel required would be dependent on the type of transportation mode selected.

Staging areas would also need to be constructed at the HMC-Grants Site to prepare tailings from the Large Tailings Pile for off-site shipment. Vehicle maintenance and fueling areas may also be needed on the HMC-Grants Site.

6. Train/Truck Transfer Facility

A temporary train/truck transfer facility would be constructed to transfer tailings from the railcars to haul trucks. The train/truck transfer facility would only be applicable for the rail transportation option and would also include additional support facilities for maintenance, fueling, and other Site support facilities.

Railcar decontamination would be integrated into the railcar transportation and unloading processes. After decontamination, the railcars would be inspected prior to release.

A haul road would need to be constructed from the train/truck transfer station to the disposal site. The length of the haul road is dependent on the location of the disposal cell in relation to the transfer station.

7. Disposal Cell Construction

The disposal cell footprint would be dependent on the final design and location of the off-site disposal cell. The primary construction and operations processes for the new disposal cell would include topsoil stripping, stockpiling, excavation, subgrade preparation, disposal cell liner installation, tailings placement, tailings compaction, disposal cell cover construction, and construction of the radon barrier.

The hypothetical disposal cell would be designed as a permanent, zero-discharge facility with stability and tailings containment under static and seismic conditions. Typically, a disposal cell consists of a primary and secondary liner system. From top to bottom, the liner would consist of (1) an upper (primary) geomembrane liner, (2) a leak collection and recovery system, followed by (3) a secondary liner consisting of another geomembrane underlain by either compacted clay or geosynthetic clay. Both geomembranes would likely be 60 millimeter thick high density polyethylene (HDPE), due to its resistance to deterioration from ultraviolet light, high tensile strength, and high-stress crack resistance. The compacted clay or geosynthetic clay would have a hydraulic conductivity of no more than 1×10^{-7} cm/sec or approved equivalent (40 CFR 264.221).

The leak collection and recovery system between the primary and secondary geomembrane layers would be designed in accordance with 40 CFR 264.221, including a bottom slope of 1 percent or more percent, drainage materials of a proper hydraulic conductivity and depth, use or materials that are chemically resistant to the tailings. The system would also be designed and operated to minimize clogging and have the ability to remove any liquids with sumps or pumps.

8. Site Reclamation

Site reclamation would occur after the last portion of the disposal cover was emplaced. The non-contaminated temporary facilities would remain until the end of cell cover placement. All disturbed areas within the contaminated zone would need to be verified to meet established cleanup standards prior to cell closure and backfill. Any contaminated material would be placed into the cell prior to reclamation and closure. The disposal cell site would be surrounded with a security fence. Final reclamation activities would be implemented at the cell disposal area and transportation facility area.

2.3.2.2 Excavation and Preparation of Tailings for Transportation

The actions at the HMC-Grants Site to excavate, prepare and process contaminated tailings material for transportation to the off-site disposal cell would depend on the mode of transportation selected for the off-site disposal alternative. The transportation alternatives are discussed further in Section 2.3.4. The material preparations for the truck and rail transport would be the same; however, the slurry pipeline option would require different material preparation requirements.

The tailings would have to be excavated and dried to specified optimal moisture content prior to truck or rail transportation. Drying methods may include drying in a process bed, thickener, or mixing with drier material. Significant land areas could be required during the drying process for both of these transportation methods. The excavation, drying and preparation systems would require erosion, sediment, and hydraulic controls to contain and divert storm events throughout the construction and transport periods. The selected methods would be developed as part of the engineering design process.

The pipeline mode of transportation would require mixing of the tailings with water to form a slurry after excavation. Haul trucks would be loaded at the point of excavation and deliver the material to a processing area or stockpile prior to slurrying the tailings.

2.3.2.3 Additional HMC-Grants Site Closure Requirements

Site reclamation activities at the HMC-Grants Site would be similar to those discussed in Section 2.2.1. HMC would continue to operate the groundwater extraction/injection system to clean up groundwater contaminated by tailings seepage. Groundwater restoration would have to be complete before an off-site disposal option could be implemented. However, the off-site disposal alternative option would involve moving the Large Tailings Pile from the Site, requiring an additional 200 acres to be reclaimed, as well as reclamation of areas used for the additional infrastructure, buildings, and staging or drying areas on the Site. Upon completion of the removal of the Large Tailings Pile from the HMC-Grants Site, final site reclamation would commence. The tailings drying infrastructure, process buildings, maintenance facilities and other transport-related facilities would have to be removed from the Site in accordance with a waste management plan that complies with all federal, state, and local regulations.

The NRC is the lead federal regulatory agency overseeing the cleanup and closure activities at the HMC-Grants Site. Currently, the HMC-Grants Site is operating under the approved reclamation plan where partial surface reclamation has occurred and final surface stabilization will occur after the groundwater remediation is complete. If the off-site disposal alternative is selected, the current reclamation plan would need to be modified or, alternatively, a new plan would be necessary. Prior to completion and approval of final closure activities at the HMC-Grants Site, a new Subsurface and Surface Completion Report for HMC-Grants Site would need to be finalized. Similarly, a new Post-Closure Monitoring and Inspection Plan for HMC-Grants Site would need to be in place prior to final closure.

2.3.3 Construction and Operations of the Borrow Area

Off-site borrow material locations would need to be identified for use as tailings cover construction material or clean backfill. A borrow material storage area would be constructed at the new off-site disposal location for temporary storage of borrow materials. Off-site dump trucks would deliver the borrow materials from the source locations (assumed to be commercial sources) to the disposal site stockpile area within a designated non-contaminated location.

Logistics of the borrow area traffic analysis is highly dependent on the mode of transportation that would be selected for the off-site disposal alternative.

2.3.4 Transportation of Tailings and Other Contaminated Material

This section describes the various possible modes of transportation that would be used in transporting the Large Tailings Pile from the HMC-Grants Site to a hypothetical off-site disposal location. A detailed evaluation of the truck, rail, and pipeline modes of transportation would not be possible until the potential off-site disposal alternative location(s) is determined. As discussed earlier, for costing purposes it is assumed that the hypothetical off-site location is 30 miles from the current HMC-Grants Site. This section briefly discusses the evaluation of various transportation options that would need to be included in the EIS process. In order to estimate the amount of time and cost associated with each of the transportation modes, general assumptions were made to simplify the cost estimation without knowing the exact location of the off-site disposal cell.

2.3.4.1 Truck Transportation

The option to transport the excavated tailings from the HMC-Grants Site via truck transportation was evaluated for a hypothetical location within a 30-mile radius from the existing Site. The truck fleet size, roundtrip time estimate, and other factors are highly dependent on the geographic location of the off-site disposal cell. Potential infrastructure issues required for the truck transportation scenario would involve a detailed traffic analysis to determine if widening of roads or construction of new roads would be required.

An important aspect of the truck transportation option for the off-site disposal alternative is the permitting processes for packaging, hazard communication, and container-specific radiological requirements. Each container must be securely covered and marked for radioactive materials use.

Some advantages to using truck transportation may include the following:

- Less infrastructure construction would be associated with truck transportation.
- Higher local employment.
- Could begin transferring tailings sooner; no rail line or slurry pipeline needs to be completed.

2.3.4.2 Rail Transportation

The logistics of rail transportation from the HMC-Grants Site to the permanent off-site disposal cell location depends on the exact location identified. Ideally, existing rail infrastructure would be used, if feasible, depending on the current rail traffic patterns and location of nearby rail infrastructure. Approximately 145 miles of existing rail is located within a 30-mile radius of the HMC-Grants Site; however, it is likely that a new rail line would need to be constructed to the proposed disposal location due to current usage levels and location of the existing rail lines.

If rail transportation were selected as the primary transportation option for the relocation of the tailings, a baseline gamma radiation exposure rate survey would need to be performed on the proposed rail line spur. The purpose of the survey would be to characterize the existing gamma exposure rates along the constructed rail line to the selected off-site disposal location. After final placement of tailings at the off-site disposal location, a post-closure radiological assessment would be required. Additionally, gamma surveys would need to be performed annually and anytime a release is suspected.

As described above, if connecting to an existing rail line is not feasible, new rail line would need to be constructed to the off-site disposal location. A rail siding would need to be constructed to connect to the newly constructed rail line. The siding would be used to load tailings onto the rail hauling trains. It is assumed that each train would consist of 30 standard-size gondola cars, carrying a maximum capacity of 100 tons in each car. The trains would be loaded with post-processed tailings, and driven to the disposal cell siding to be unloaded prior to returning to HMC-Grants Site for an additional load. The loading process would involve a conveyor and hopper system and the unloading process would be performed by a rotary dump mechanism to rotate each train and dump the material. Loaded cars would be decontaminated at the loadout station before leaving HMC-Grants Site and prior to leaving the off-site disposal location for the return trip.

As with the truck option, an important aspect of the rail transportation option for the off-site disposal alternative is the permitting processes for packaging, hazard communication, and container-specific radiological requirements. Each container must be securely covered and marked for radioactive materials use.

Some advantages to using rail transportation include the following:

- Public safety; less truck traffic on the selected truck transportation route.
- More tailings can be transported each trip.
- Fuel costs would be reduced.
- Labor costs would be reduced, fewer employees required.

2.3.4.3 Slurry Pipeline Transportation

The slurry pipeline transportation alternative would require the construction of a buried double-walled pipeline from the HMC-Grants Site to the permanent off-site disposal location for both slurry and a return water pipeline. The tailings would be mixed with water at the HMC-Grants Site. After complete mixing, the semi-solid liquid would be pumped via the slurry pipeline to the final disposal site. At the disposal site, the slurry would be dried and placed in the disposal cell. Potential drying methods may include vacuum filtration system. The recovered water would be pumped back to HMC-Grants Site through a second pipeline to the slurry preparation area for reuse. Siting studies would be required to determine an adequate pipeline corridor. Water holding ponds for the return water, and possibly for treatment of the water, would need to be constructed at the disposal cell site.

The slurry and water pipelines would need to be double-walled in order to constrain any leaks in the line. The inner pipe would be HDPE in both cases, with a very thick wall to prevent the abrasive slurry from degrading the pipe. For the slurry, a 36-inch diameter HDPE pipe was used for costing purposes, with an outer steel pipe with a diameter of 42 inches. For the return water line, a 26-inch HDPE pipe with a 32-inch steel pipe casing was used for costing purposes. Additionally, a midline pumping station was assumed to be needed to maintain pressure and flow of the slurry.

Ideally, the proposed pipeline corridor would follow existing gas or oil pipeline right-of-way or road rights-of-way. The final placement of the pipeline corridor is highly dependent on the location of permanent off-site disposal location.

Some advantages to using slurry transportation include the following:

- Public safety; no truck traffic.
- Fuel costs would be reduced.
- Labor costs would be reduced, less employees required.

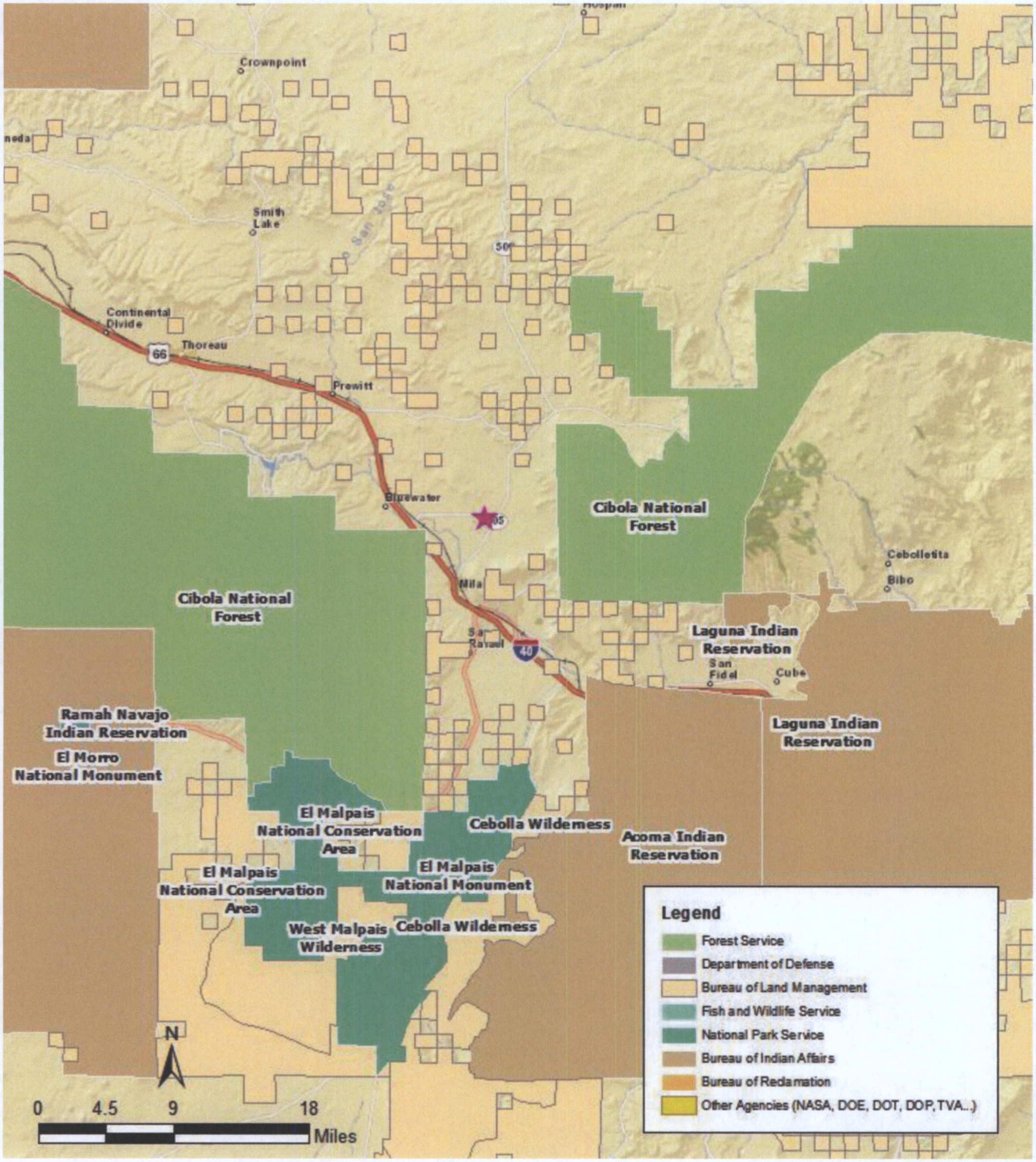
2.3.5 Environmental Justice and Public Involvement

Relocation of the Large Tailings Pile has the potential to affect cultural and historic resources in the region. Cultural impacts to Native American communities are a concern and would need to be addressed during the siting process. There are Native American lands along the I-40 corridor to the east of the Site as well as bordering the Cibola National Forest and Cebolla Wilderness Area (Figure 2-3).

Public hearings and community outreach would necessarily occur as potential relocation sites are identified, as community input must be sought for identification of the potential location of the off-site disposal cell. Such meetings would occur prior to the EIS, which would focus only on relocation sites that are acceptable to the affected communities.

Public hearings would also be required during the EIS process, and a 90-day public comment period during the scoping meeting would be required. During the EIS process, comments would be received from the public and from agencies. These comments are critical for evaluating the alternatives. In the event that off-site disposal is further explored, public involvement will play a key role in the success of future investigations and site selection. Promoting public involvement at every level of the identification stage of the off-site disposal cell location would be critical to ensuring that citizens' concerns are addressed and that relevant public information is provided. Public involvement would be encouraged and site-specific information would be provided to stakeholders. Public meetings would be held with the various stakeholders, which would include tribal officials, state officials, local officials, regional tribes, citizen groups, environmental groups, and the general public.

U:\PROJECTS – CONFIDENTIAL\1159520013 – HOMESTEAD\FIGURES\FIGURE 2-3 FEDERAL LANDS.DOCX SAVED: 6/26/12 PRINTED: 6/26/12 BY: CHRISTEL GRAY



★ **Homestake Superfund Site**

Project No. 1159520013

April 2012

Figure 2-3
Federal Lands

2.3.6 Monitoring and Maintenance of Off-site Disposal Cell

After completion of the tailings placement and site reclamation, monitoring and maintenance of the off-site disposal cell would be in accordance with the LTS&M Plan approved by the NRC. The LTS&M Plan would describe how future actions at an off-site disposal cell will maintain protection of human health and the environment. The LTS&M Plan should also to be consistent with the requirements of CERCLA.

Site maintenance would involve inspection and repair of drainage facilities at the disposal cell. The primary maintenance requirements would be dependent on the final design and construction of the facility. In general, the primary activities would include site inspections, maintenance and repair, environmental and geotechnical monitoring, and reporting requirements. The long-term inspection and monitoring activities at the off-site disposal location would likely include subsidence, groundwater, surface water, radon, erosion, and vegetation monitoring at the reclaimed site.

The radiation monitoring requirements for an off-site tailings disposal cell are similar to those for a mill site with on-site disposal cells. During placement of tailings in the off-site cell and prior to the installation of the final cover, airborne particulates, radon, and direct gamma radiation monitoring would be necessary. Assuming the off-site disposal cell is deeded to the DOE in the same manner as would be the case for an on-site disposal cell, groundwater monitoring would become the eventual responsibility of the federal government. Such monitoring costs presumably would be covered by the long-term maintenance fund provided by the licensee at the time of closure and license termination.

Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills" (NRC, 1980), provides "guidance" with regard to monitoring locations, schedule, and minimum detectable concentrations for various environmental media including soil, vegetation, water, and air. The specifications in Regulatory Guide 4.14 are minimum requirements and are likely to be more stringent in the near future as the planned revision of the regulatory guide is published and implemented. The minimum expected monitoring requirements for an off-site cell, based on Regulatory Guide 4.14, are summarized in Table 2-5. If there are surface water bodies in the near vicinity of the off-site disposal cell, food, fish, surface water, and sediment samples would be required as specified in Regulatory Guide 4.14. The minimum detectable concentrations (MDCs) required by Regulatory Guide 4.14 are given in Table 2-5.

The provisions of NUREG-1620, Standard Review Plan for the Review of a Reclamation Plan for Mill Tailings Sites Under Title II of the Uranium Mill Tailings Radiation Control Act of 1978 (NRC, 2003) would be applicable to any off-site disposal cell. Section 5.3.3 of NUREG 1620 requires that the radiological monitoring program be consistent with Regulatory Guide 4.14 with the additional provision that site-specific aspects of climate and topography be considered in determining the locations of airborne monitoring stations and sampling areas, but adequate to detect maximum off-site concentrations of tailings-related materials for all transport pathways. This may require a more extensive monitoring system than that provided for in Regulatory Guide 4.14.

The NRC's "Draft Interim Guidance, Evaluations of Uranium Recovery Facility Surveys of Radon and Radon Progeny in Air and Demonstrations of Compliance with 10CFR20.1301" (NRC, 2011) notes that there are "...difficulties in predicting locations of the expected highest radon concentrations..." due to variability in air flow. This indicates that the number of radon monitoring stations necessary to accurately determine the maximum off-site concentration may be significantly greater than that required in Regulatory Guide 4.14. There are currently a total of eight radon monitoring stations at the perimeter of the HMC-Grants Site in addition to a background station. The number of existing monitoring stations may be partially due to the presence of multiple sources of radon attributable to the tailings piles and evaporation ponds, whereas the off-site disposal cell would be the only attributable radon source and may not require as many monitoring stations. However, it is also possible that an off-site disposal cell would have variable air flow conditions, common in New Mexico, requiring enhanced environmental radon monitoring. In addition, the number of monitoring stations required is dependent on the locations potentially occupied or used by members of the public in the vicinity of the site. Radon flux measurements would be required annually during placement of tailings in the off-site cell and one time after installation of the final cover to ensure that the 20 picocuries per meter squared-second (pCi/m^2-sec) flux limit is not exceeded.

Regulatory Guide 4.14 also specifies groundwater monitoring requirements for operating facilities that would most likely apply to an off-site disposal cell. Those requirements are summarized in Table 2-5.

A full year of pre-operational or baseline measurements is generally necessary prior to construction of tailings disposal facilities and would be prudent for the off-site disposal cell. The baseline measurements must be consistent with the operational monitoring requirements. In addition to the air, water, and soil measurements, pre-operational monitoring for the off-site disposal cell location would include food as well as fish and sediment if there are any streams or other water bodies in the vicinity. Baseline radon flux measurements would also be required.

The monitoring requirements after closure of the off-site disposal cell primarily involve stability rather than measurement of release of radionuclides to the air and water. This would become the responsibility of the DOE and would be defined in the LTS&M Plan.

2.3.7 Resource Requirements

The following subsections discuss the potential resource requirements for the off-site disposal alternative.

2.3.7.1 Labor

The off-site disposal alternative would require construction labor to be performed at the HMC-Grants Site and at the selected disposal cell location. Additionally, it would also require transportation-related labor which is dependent on the mode of transportation used.

Staff would need to be present on site seven days per week performing security and maintenance activities at both the HMC-Grants Site and the new off-site disposal cell. Staff at the HMC-Grants Site would be working on excavation, closure, and groundwater operation activities, while the staff at the disposal cell site would be constructing the disposal cell and site infrastructure. Staff would be required to place the tailings once the construction of the new disposal cell is completed. Additionally, transportation personnel would be working to transport the tailings to the new disposal cell location. Radiation protection and safety personnel would be present for all phases of the project at both the HMC-Grants Site and at the new disposal cell.

2.3.7.2 Equipment

The off-site disposal alternative would require construction equipment at the HMC-Grants Site and the permanent off-site disposal location. The type of construction equipment at both sites is assumed to be the same for removal of the Large Tailings Pile and construction of the new disposal cell; however, types of equipment would vary for the mode of transportation selected. Further, additional equipment would be needed to construct and maintain the transport routes, including access roads, slurry pipeline, or rail lines, depending on the mode of transportation used for the tailings relocation.

2.3.7.3 Land Disturbance

The estimated land disturbance for the off-site disposal cell is dependent on the location of the proposed disposal cell and the mode of transportation required. The disturbances would result from construction of facilities and buildings at the HMC-Grants site ("origin" location), construction of the disposal cell at the off-site location ("terminal" location) including disposal cell excavation, construction of infrastructure at the disposal cell, construction of transportation infrastructures, and excavation of borrow material. Additional infrastructure resulting in land disturbance activities at both the origin and terminal locations include access roads, entrance stations, maintenance facilities, administration buildings, guard stations, and surface water drainage systems.

2.3.7.4 Fuel

Fuel consumption for the off-site disposal alternative would be dependent on the mode of transportation selected and the construction infrastructure required with each mode. The fuel consumptions related to construction at the origin and terminal locations and for borrow material transport would be independent of the type of transportation mode selected. Fuel consumption for tailings movement is estimated for each type of transportation in the costs (Section 6.3), but does not include fuel consumption during construction or from the use of personal vehicles by workers. Fuel consumption for the project would increase significantly with implementation of the off-site disposal method as compared to the on-site alternative.

A fuel storage and refueling area at both the origin and terminal locations would be needed, and likely would be located within the radiation control area of each, to service the transportation vehicles used both for transporting tailings between the two locations (trucks or locomotives) and vehicles used to transport tailings from staging or processing areas. It is assumed that storage capacity of 20,000 gallons each of diesel and gasoline fuel would be needed at the HMC-Grants Site and at the off-site disposal cell location. Adequate spill prevention, pollution control, and control counter-measures would need to be implemented.

2.3.7.5 Water

The estimated potable and non-potable water consumption for the three transportation modes would vary. The slurry pipeline option would require the greatest amount of water. The water resources and quality would be dependent on the final siting of the off-site disposal cell. Water rights issues could potentially play a role in determining water source options. Water use at the HMC-Grants Site would increase from current levels due to dust suppression, vehicle decontamination and, if selected, slurry pipeline transport. Potable water demand would also increase as the number of on-site workers would increase.

2.3.7.6 Solid Waste Disposal

Solid waste disposal generated for the off-site disposal alternative would include the combination of the existing solid waste generated at the HMC-Grants Site as well as any additional solid waste generation at the off-site disposal cell location. Additional discussion is included in Section 3.15.1 regarding the affected environment as it pertains to solid waste disposal and management for the off-site disposal alternative.

2.3.7.7 Sanitary Waste Disposal

Sanitary waste disposal management and infrastructure requirements for the off-site disposal alternative would be highly dependent on the mode of transportation selected and number of required employees. Sanitary disposal at the HMC-Grants site would increase with additional personnel on the site, requiring either expansion or replacement of the current system. A sanitary waste disposal management system would have be developed and installed at the off-site disposal cell location. Additional discussion is included in Section 3.15.1 regarding the considerations and affected environment in regards to waste disposal infrastructure needs.

2.3.7.8 Electric Power

The estimated power demands associated with the off-site disposal alternative would depend primarily on the mode of transportation selected. The costs and sizing for the electric power supply infrastructure are dependent on the location of the hypothetical disposal cell. Major demands at the selected off-site disposal location would generally include the following:

- Field office trailers
- Worker facilities
- Parking lot and security lighting
- Pipeline slurry system (pipeline transportation)
- Train transfer station (rail transportation)
- Maintenance facilities

Table 2-4. Expected Environmental Monitoring Requirements for the Off-Site Disposal Cell

Environmental Medium	RG 4.14 Minimum Number of Monitoring Locations	Monitor Placement	Monitoring Schedule	Nuclide Analyses
Air Particulates	5	Three downwind; one nearest resident; one background	Weekly filter exchange; quarterly composite	U-nat, Ra-226, Th-230, Pb-210
Radon gas	5	Same as air particulates	Monthly (note – radon gas measurement generally quarterly if continuous)	Rn-222
Radon Flux	100 locations on each tailings impoundment or cell	Each cell or impoundment	Annually	Rn-222
Groundwater	Four	Close to the impoundment; three downgradient; one upgradient	Monthly downgradient year 1; quarterly thereafter and downgradient	U-nat (diss.), Ra-226, Th-230, Pb-210, Po-210
Drinking water wells	Each well	Each well	Quarterly	U-nat (diss. and susp.), Ra-226, Th-230, Pb-210, and Po-210
Vegetation	Three	In the direction of the highest predicted airborne radionuclide concentrations	Three times per year during the grazing season	Ra-226, Pb-210
Soil	Five (or more)	At each air particulate monitoring station	Annually	U-nat, Ra-226, Pb-210
Direct radiation	Five	At each air particulate monitoring station	Quarterly	Integrated gamma dose

Table 2-5. Minimum Detectable Concentrations for Radionuclides in Environmental Media

Medium	Nuclides	Minimum Detectable Concentration
Air	U-nat Th-230, Ra-226	1×10^{-16} µCi/mL
Air	Pb-210	2×10^{-15} µCi/mL
Air	Rn-222	2×10^{-10} µCi/mL (0.2 pCi/L)
Water	U-nat, Th-230, Ra-226	2×10^{-10} µCi/mL
Water	Po-210, Pb-210	1×10^{-9} µCi/mL
Soil/sediment	Up-nat, Th-230, Ra-226, Pb-210	2×10^{-7} µCi/g (dry)
Vegetation/food/fish	U-nat, Th-230	2×10^{-7} µCi/kg
Vegetation/food/fish	Ra-226	5×10^{-8} µCi/kg
Vegetation/food/fish	Po-210, Pb-210	1×10^{-6} µCi/kg

3.0 CONSIDERATIONS OF AFFECTED ENVIRONMENT FOR OFF-SITE DISPOSAL

The following subsections describe environmental considerations that would be associated with an off-site disposal alternative. All considerations are hypothetical in that a relocation site has not been identified, but these considerations would apply and require full evaluation if off-site disposal were to be implemented.

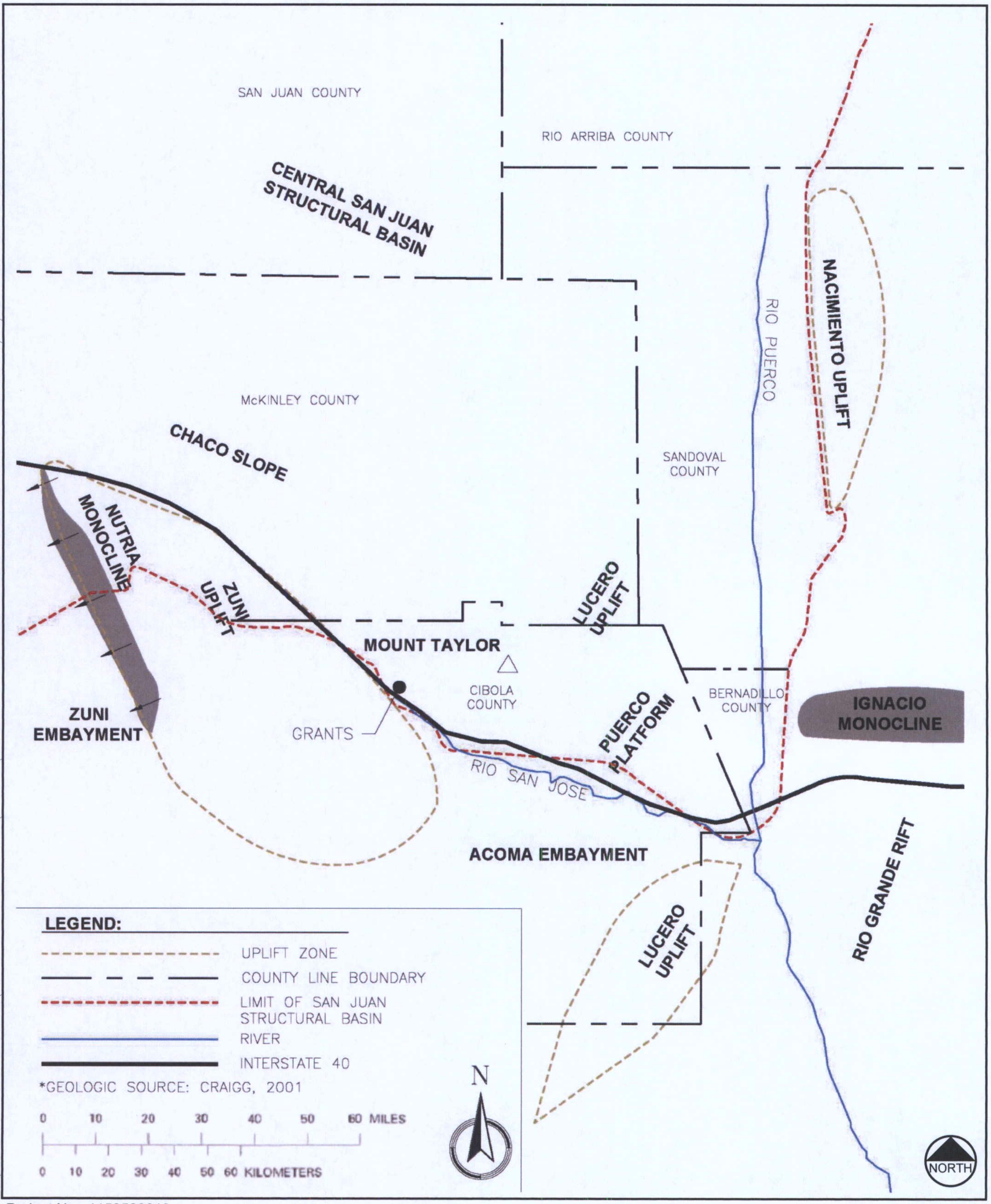
3.1 Geology

The general Grants millsite area is situated in the southeastern part of the Colorado Plateau physiographic province (U.S. Geological Survey [USGS], 2012). The geology of the region proximal to the Grants site is highly varied. The area straddles the boundaries between the San Juan structural basin to the north, the Zuni Uplift to the west and, to the east, the Puerco Fault Zone, the Puerco Platform and the Acoma Sag (Dam et al., 1990) (Figure 3-1, physiographic and structural setting showing mentioned features). Elevations range from about 11,300 feet above MSL on Mount Taylor to about 5,800 feet above MSL where the Rio San Jose leaves the area. The topography varies from the steep slopes of the flanks of Mount Taylor, the edges of some mesas and the hogback ridges of some bedrock outcrops to rough-surfaced mesas developed on lava flows and rolling topography extending north into the San Juan structural basin.

3.1.1 Stratigraphy

Details of the stratigraphy of the area are presented in Baldwin and Rankin (1995) and Stone et al. (1983) and are summarized in Table 3-1 (stratigraphic column with hydrogeologic information). The area is underlain by igneous and metamorphic basement rocks of Precambrian age which are exposed in the core of the Zuni Mountains in the southwestern part of the area (**Error! Reference source not found.**, geologic map) (Stoeser et al., 2005; New Mexico Bureau of Geology and Mineral Resources, 2003; Baldwin and Rankin, 1995; Stone et al., 1983). The Precambrian rocks consist of granite, gneiss, metarhyolite, schist, and quartzite.

Sedimentary rocks ranging in age from Pennsylvanian to Cretaceous overlie the Precambrian basement and are exposed in outcrop or present in the subsurface throughout the area except where the Precambrian rocks are exposed. Paleozoic (Pennsylvanian and Permian) sedimentary rocks crop out in and surrounding the Zuni Mountains. The Pennsylvanian rocks are composed of conglomerate, arkose, shale and limestone deposited in continental, near-shore and marine environments. Permian rocks include the Abo and Yeso formations, the Glorieta Sandstone, and the San Andres Limestone. The Abo Formation is composed of a basal conglomerate overlain by sandstone and siltstone deposited in fluvial and near-marine conditions. The Yeso Formation consists of gypsiferous shale, siltstone, silty sandstone, and minor limestone of marine origin.

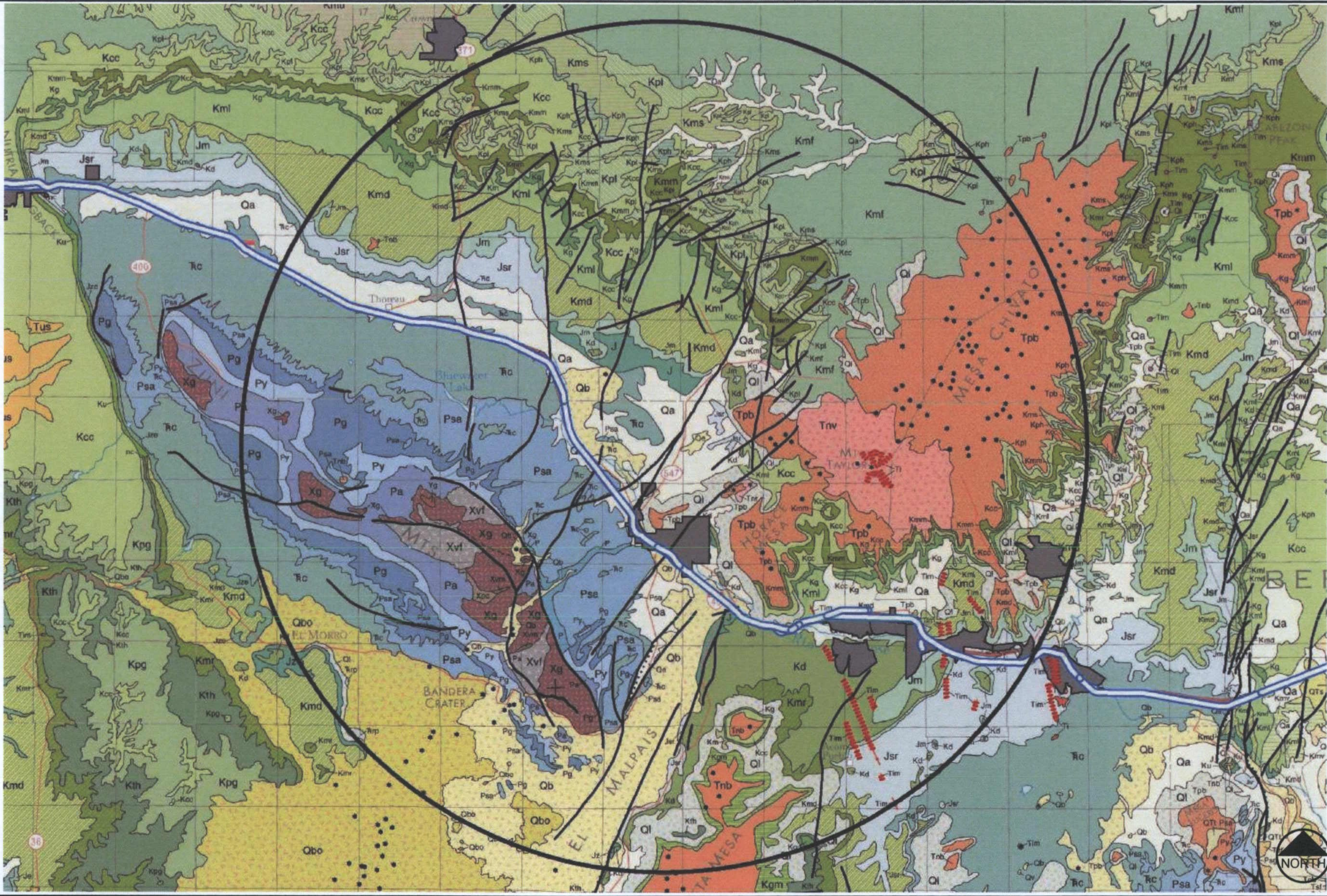


U:\PROJECTS – CONFIDENTIAL\1159520013 – HOMESTEAD\FIGURES\FIGURE 3-1 STRUCTURAL FEATURES OF REGION.DOCX SAVED: 4/13/12 BY: CHRISTEL GRAY

Project No. 1159520013

April 2012

Figure 3-1
Structural Features of Grants, New Mexico Region



Project No. 1159520013

March 2012

30mi Radius — Faults

• Vents — Dikes

See Table 3.1 for Formation Symbols

0 5 10 20

Miles

Figure 3-2
Regional Geologic Map

Table 3-1. Summary of Stratigraphic Units

Era	Age	Group	Formation	Member	Geologic Map Symbol	Thickness (ft)	Lithology
Cenozoic	Quaternary		Alluvium		Qa	0-200	Unconsolidated sand, silt, gravel present as channel-fill or blanket-type deposits
			Basalt		Qb, Qbo	0-320	Basalt flows of North Plains, Rio San Jose valley and Fence Lake area
			Landslides		Ql	Insufficient data	Insufficient data
	Quaternary and Tertiary		Basalt		Tpb	0-1,000	Basalt flows
			Mount Taylor Volcanics		Tnv	0-3,000	Basalts interbedded with mudflows, volcaniclastic debris, dikes and pyroclastic flow material
			Igneous Intrusives		Ti, Tim	Insufficient data	Intrusisve dikes, sills and plugs
Mesozoic	Cretaceous	Mesaverde Group	Menefee Formation		Kmf	400-1,000	Interbedded claystone, shale, coal, sandstone
			Point Lookout Sandstone		Kpl	40-415	Marine sandstone
				Hosta Tongue	Kph		
			Crevasse Canyon Formation	Gibson Coal Member	Kcc	100-1,000	Marine sandstone, mudstone, shale, minor coal
				Dalton Sandstone Member			
				Dilco Coal Member			
			Gallup Sandstone		Kg	0-700	Marine sandstone, carbonaceous mudstones, thin coal beds
			Mancos Shale	Satan Tongue	Kms	225-385	Marine shale
				Mulatto Tongue	Kmm		
				Lower Member	Kml		
			Dakota Sandstone		Kd	0-350	Marine, marginal marine and nonmarine silty sandstone, thin coal beds
	Jurassic		Morrison Formation	Jackpile Sandstone Member	Jm	0-200	Fluvial, flood-plain, channel deposits. Upper and lower members have high proportion of clay and mucstone. Middle member is fine- to medium-grained sandstone
				Brushy Basin Member		220-300	
				Westwater Canyon Member		90-120	
				Recapture Member		75-200	
			Zuni Sandstone		Jz	0-500	Fine-grained eolian sandstone
		San Rafael Group	Bluff Sandstone		Jsr	0-400	Fine- to medium-grained eolian and fluvial sandstone
			Summerville Formation			0-200	Fine-grained sandstone and silty mudstone
			Todilto Limestone			10-110	Thin limestone overlain by gypsum and anhydrite
			Entrada Sandstone		Je	0-350	Fluvial sandstone, intertidal siltstone
	Triassic		Wingate Sandstone		Trw	80-325	Fluvial siltstone, mudstone, sandstone, bedded channel sandstone, minor limestone
			Chinle Formation	Petrified Forest Member	Trc	0-2,080	
				Monitor Butte Member			
			Moenkopi Formation				
Paleozoic	Permian		San Andres Limestone		Psa	0-450	Marine fossiliferous limestone with some interbedded sandstone, gypsum beds in east
			Glorieta Sandstone		Pg	0-300	Massive, fine-to medium-grained, well-cemented intertidal sandstone
			Yeso Formation	San Ysidro Member	Py	0-1,400	Gypsiferous shale, siltstone, silty sandstone, minor interbedded limestone
				Meseta Blanca Member			
			Abo Formation		Pa	300-1,200	Sandstone and siltstone with conglomerate in lower part
Proterozoic	Precambrian		Undifferentiated rocks		Xg, Xvf	Insufficient data	Granite, gneiss, metarhyolite, schist, quartzite

Progressively younger Mesozoic (Triassic, Jurassic, and Cretaceous) sedimentary rocks crop out to the north and east of the Paleozoic rocks (Figure 3-2). The Triassic rocks are of continental (nonmarine) origin and include fluvial sandstone and siltstone, mudstone, and minor limestones of the Moenkopi, Chinle, and Wingate formations. Jurassic sedimentary rocks in the area are mainly of continental origin and of lithologies similar to the Triassic rocks. Jurassic formations include the Entrada Sandstone, Todilto Limestone, Summervile Formation, Bluff and Zuni Sandstones, and the Morrison Formation. Economic deposits of uranium are present in the Westwater Canyon Member of the Morrison Formation. Deposition of the Jurassic sediments was followed by a long period of exposure during which much of the Jurassic rocks were removed by erosion before encroachment of the sea during Cretaceous time. Cretaceous rocks in the area include the Dakota Sandstone, Mancos Shale, Gallup Sandstone, Crevasse Canyon Formation, Point Lookout Sandstone of the Mesaverde Group, and the Menefee Formation. These units include a series of interbedded and intertonguing sandstones, siltstones, shales, mudstones, and minor coal beds that were deposited in continental, marginal marine and marine environments that varied with cyclically fluctuating sea levels and transgressing and regressing shorelines.

Cenozoic (Tertiary and Quaternary) age intrusive and extrusive volcanic rocks are found along the northeast-southwest trending Jemez Lineament. Mount Taylor is a composite volcano that rises more than 3,000 feet above the surrounding areas. Basaltic lava flows that emanated from cinder cones and intrusive dikes blanket the sedimentary rocks and cap mesas in the eastern, southern, and southwestern parts of the area. The youngest volcanics are 400 to 1,000 years old. The extrusive volcanic materials generally comprise flows with massive-structured interiors and brecciated or rubblized interflow zones and perimeters.

Quaternary age unconsolidated alluvial, colluvial and landslide deposits are present in valleys bottoms and on slopes scattered throughout the area. Alluvial sand and gravel deposits of significant thicknesses are found along the Rio San Jose, Arroyo del Puerto, and San Mateo Creeks, as well as other drainages in the area. Landslide deposits are present adjacent to the margins of some of the basalt-capped mesas in the area, Mesa Chivato, Horace Mesa, and Cebollita Mesa.

3.1.2 Structure

The major structural features of the region are shown on Figure 3-1. These include the northwest-trending Zuni Uplift, centered in the Zuni Mountains In the western and southwestern part of the area, and the San Juan structural basin to the north. The Acoma Sag is a synclinal feature east of the southeastern end of the Zuni Uplift. In general, the sedimentary rocks in the area dip away from the Zuni Mountains gently (at dips of 2 to 3 degrees) northeastward into the San Juan structural basin and slightly more steeply (at dips of 4 to 6 degrees) eastward into the Acoma Sag and southwestward into the Zuni Embayment. Northeast of the Zuni Mountains, in the Chaco Slope structural area, the dip of the sedimentary rocks decreases to about one degree (Craigg, 2001).

Numerous north-south and northeast-southwest trending normal faults offset the sedimentary rocks along the Chaco Slope in the southern part of the San Juan structural basin, and northwest-southeast trending faults offset the Precambrian and Paleozoic rocks in the Zuni Mountains. Typically, the structural offsets along these faults are relatively small – not more than a few hundred feet – although many of the faults extend for several tens of miles. Smaller-scale folds have developed along with or as a result of these faults and locally alter the dips of the sedimentary rocks. The Jemez Lineament extends northeast through Mount Taylor and across the eastern side of the area. It is postulated (Magnani et al., 2004) to be a zone of crustal weakness developed along the suture zone marking the location at which island arc rocks accreted to the proto-North American continental crust. It provides the source of the volcanic rocks present in the area.

3.1.3 Geologic Resources

New Mexico Bureau of Geology and Mineral Resources publications (McLemore et al., 1986a, 1986b, 2005) describe past and current exploitation of and potential for the following geologic resources in the area:

- Uranium (with vanadium and molybdenum)
- Coal
- Base and precious metals (copper, lead, tin, gold, and silver)
- Petroleum and natural gas
- Pumice, perlite and scoria
- Sand and gravel
- Crushed and dimension stone
- Gypsum
- Limestone
- Fluorite, barite
- Mica
- Clay
- Geothermal

The most notable geologic resource of the area is uranium-vanadium deposits hosted in the Westwater Canyon Member of the Morrison Formation north of I-40 in the Ambrosia Lake, Smith Lake, Laguna, and Marquez areas of the Grants uranium district. These deposits have been mined extensively since the 1950s.

Coal is found in the Menefee and Crevasse Canyon formations and the Gallup Sandstone. Delineated coal fields include, clockwise from the northwestern side of the area, the Crownpoint, San Mateo, Mount Taylor, Marquez, Datil Mountains, and Zuni coal fields. Coal has been mined historically from all of these areas. The potential for petroleum resources in the area is reported to be low to moderate; the nearest oil field is slightly more than 30 miles from the Grants mill site.

Copper, gold, silver, and lead were mined from Precambrian rocks in the Zuni Mountains from 1905 to about 1965. The Precambrian rocks in the Zuni Mountains also offer moderate potential for crushed and dimension stone and some potential for minable fluorite, barite, and mica. There is an unknown potential for tin and beryl in the volcanic rocks of Mount Taylor. The Mount Taylor and Zuni Mountains areas may offer potential for providing geothermal resources, but insufficient research has been conducted to confirm the resource.

Perlite and pumice were mined from the East Grants Ridge district from 1946 to 2000, and scoria is available from the extensive volcanics and lava flows. Sand and gravel resources are present in the alluvial deposits along the Rio San Jose and possibly in other areas.

Limestone and gypsum would be available from the San Andres Limestone and Todilto Formation in the Zuni Mountains and possibly other areas. Clay may be available from the Cretaceous rocks in the area; brick clay was mined historically in the Gallup area.

3.1.4 Geologic Hazards

Geologic hazards in the area include the following:

- Mass wasting: Rockfall hazards occur primarily in areas adjacent to elevated outcrops of competent, cliff-forming rock such as sandstone, limestone, or volcanics. Landslides and debris flows could occur in most areas with steep topography and are generally triggered by excessive precipitation or seismic events.
- Erosion: Long-term, gradual erosion will occur throughout the area, and catastrophic erosion events may occur along stream channels in response to precipitation and runoff. Erosion by piping may occur in fine-grained soils, particularly along ephemeral or perennial stream channels.
- Earthquakes: Hazards from ground motion caused by earthquakes exist in all areas. For this area, the peak ground acceleration with two percent probability of exceedance in 50 years ranges from about 0.08 to 0.16 g (2.56 to 5.12 feet per second per second) (Petersen et al., 2008).
- Faults: Differential motion of the ground on opposite sides of a fault can occur.
- Subsidence: Subsidence of the land surface can occur over features in this area such as underground mines in the uranium mining areas and cave-like lava tubes in the areas underlain by volcanic rocks. In addition, subsidence related to paleokarst features in the San Andres Limestone can occur in the San Andres outcrop areas.
- Volcanic eruptions: Although no active volcanoes are known in the area, the youngest lava flows are only 400 to 1,000 years old. On the basis of the young ages of the lava flows, volcanic activity is a possibility, particularly along the Jemez Lineament.

3.2 Soils

The suitability of a waste burial site is a function of the hydrologic processes that control the near-surface water balance. Early evaluation of general hydrologic conditions at and near the Mojave Waste-Burial Site in Nevada (Andraski et al., 1995) suggested that a low average annual precipitation and high average annual evapotranspiration would prevent water from percolating downward more than one or two feet below land surface. Water movement in the unsaturated zone is complex. Numerous variables such as water content, water potential, humidity, and temperature must be monitored to define rates and direction of water movement. Water moves through soil in liquid and vapor form, and the two forms can move simultaneously as a consequence of water-potential, humidity, and temperature gradients in the soil. Ongoing investigations at undisturbed and vegetated areas of the Mojave site indicated that the natural soil-plant water system effectively limits the potential for deep percolation (Andraski et al., 1995).

Water movement is naturally limited where thick, fine grained soils store precipitation until soil evaporation and plant transpiration seasonally return it to the atmosphere (DOE, 2005). In addition, the soils should have minimal water-erosion potential and hazard of blowing potential.

3.3 Air Quality

3.3.1 Excavation of Existing Tailings – Impacts in HMC-Grants Area

Air quality impacts from off-site disposal of the tailings that are currently under an interim cover on the HMC-Grants Site include increased air particulate and radon concentrations resulting from excavation of the contaminated materials. Air quality would be impacted in both the area surrounding the existing facility and the off-site area selected for the new disposal cell.

Excavation of 20 million tons of tailings and approximately 2 million tons of cover materials and impacted soils from beneath the Large Tailings Pile would result in emission of air particulates. Excavation and placement of this material would be expected to result in emission of 0.023 pounds (lbs) per ton of material based on estimated emission from transfer of fine ore (NRC, 1987). Over the course of the removal of tailings, cover materials and impacted soils from the existing impoundment, a total of 5.1×10^5 lbs of material could be released. Assuming a 10-year project duration, the release rate would be 5.1×10^4 per year. Most of the dust would settle out within a short distance from the point of generation, depending on the wind and atmospheric stability conditions. Dust suppression techniques such as adequate watering might decrease the emission rate during excavation. While tailings are somewhat different from fine ore, estimates based on this emission factor are reasonable surrogates for actual tailings emissions.

Radon emissions during excavation of tailings would be expected to increase ambient radon concentrations in the vicinity of the mill. Assuming an emanation fraction of 0.2, Ra-226 concentration in tailings of 530 pCi/g, and that all radon in the pore space is released during disturbance, the total radon release would be approximately 2,100 Ci. The concentration would depend on the time over which the excavation takes place. Assuming a total mass of tailings, cover materials and soil of 22,000,000 tons and truck capacity of 40 tons, a total of 550,000 truckloads would be required. Completing excavation and transport over a 10 year period would require 150 truckloads per day, 7 days per week, and 52 weeks per year. The release of radon would presumably be spread out over the 10 year period for an annual release rate of 210 Ci. These calculations assume that the tailings are directly loaded into the trucks rather than stockpiled and moved twice. If the tailings are stockpiled prior to transport to the new disposal cell, the annual release rates for both particulates and radon gas would be doubled to approximately 1×10^5 lbs and 420 Ci respectively.

Depending on how the excavation of the tailings is carried out, the radon emissions from the tailings pile may be increased as the interim cover is removed. Particulate emissions from the uncovered tailings could also increase as the material is excavated. The increase could be minimized by staging the removal of the cover and excavation of tailings so that only a small portion of the tailings are uncovered at any one time. A quantitative estimate of the impact is not possible without a specific Work Plan.

The use of heavy equipment to excavate the tailings would result in emission of carbon monoxide as well as sulfur oxides (SOX) and oxides of nitrogen (NOX). The estimates in the Moab FEIS indicate tailpipe emission levels of 3,100 grams per hour (g/h), 8,800 g/h, and 880 g/h, respectively for these pollutants (DOE, 2005). In addition, the total particulate emissions from the equipment were predicted to be approximately 3,200 g/h. The estimated concentrations for the Moab site were well below the standards in all cases.

3.3.2 Impacts during Transport

Particulate emissions from incident-free truck or rail transport would be minimized by covering the tailings in the truck bed or rail car with a tarp. Assuming immediate transport of the tailings to the new disposal cell, radon gas levels in the material would most likely not build in to levels that would allow significant radon emission during transport.

Concentrations of criteria pollutants in air due to transportation projected for the Moab Site were also only a small fraction of the standards (DOE, 2005). Even assuming twice the truck traffic for relocation of the HMC-Grants Large Tailings Pile, the criteria pollutant standards would not likely be exceeded.

Impacts from slurry transport include possible breaks or leaks in the pipeline. While a double walled system would be used, accidental breaks in the line that breach both the inner and outer piping could result in large releases of radioactive slurry to the environment. Slurry is abrasive due to its physical composition, and may deteriorate the inner pipeline during transport and cause leaks in the inner pipeline. Replacement of damaged inner pipe would require replacement of impacted sections of both the inner and outer pipes. It is possible that releases to the environment could occur while such repairs are conducted.

3.3.3 Impacts in the New Disposal Cell Area

Particulate emissions during placement of the tailings in a new disposal cell would be approximately the same as the emissions during excavation. Radon emissions would be expected to be a fraction of the emission during excavation since the assumption is that all of the available radon would be released during the initial disturbance. If the time between excavation and placement in the new cell is less than one day, the amount of radon released would be less than 20 percent of the radon released during excavation.

Concentrations of criteria pollutants in ambient air due to emissions from construction equipment would be approximately the same at the new disposal cell area as are predicted for the initial excavation of the tailings.

3.4 Climate and Meteorology

The elevation range within the area of interest ranges between of 6,600 feet and 11,300 feet above MSL and is a typical high desert climate.

The average precipitation is 10.4 inches and evaporation of 54.6 inches per year. The maximum precipitation typically occurs due to thunderstorms in July, August, and September. July and August are the rainiest months, with 30 to 40 percent of the year's total moisture falling at that time. During the warmest six months of the year, May through October, total precipitation averages 60 percent of the annual total in the Northwestern Plateau. Summer rains fall almost entirely during brief, but frequently intense thunderstorms. The general southeasterly circulation from the Gulf of Mexico brings moisture from the these storms to the area, and strong surface heating combined with orographic lifting as air moves over higher terrain causes air currents and condensation. Evaporation is highest in May, June, and early July because the onset of the rainy season (usually in mid-July) reduces evaporation in the second half of the summer. Heavy summer thunderstorms may bring several inches of rain to small areas over a small span of time. Because of the rough terrain and sparse vegetation in the area, runoff from these storms, frequently cause local flash floods. Snowmelt during April through June, especially in combination with a warm rain, and heavy general rains during August to October may occasionally cause flooding in larger rivers in the area.

Average precipitation for the remainder of the year is roughly one-half inch each month. Winter precipitation is caused mainly by frontal activity associated with the general movement of Pacific Ocean storms across the country from west to east. Much of the winter precipitation falls as snow in the mountain areas, but it may occur as either rain or snow in the valleys.

The potential evaporation is much greater than the annual precipitation. During the summer months, evaporation ranges from nearly 41 inches in the north-central portion of the state.

Average relative humidity in the region is lower in the valleys and higher in the mountains. Relative humidity ranges from an average of near 65 percent about sunrise to near 30 percent in mid-afternoon; however, afternoon humidity in warmer months is often less than 20 percent and occasionally may go as low as 4 percent.

Wind speeds in the area are usually moderate, although relatively strong winds often accompany occasional frontal activity during late winter and spring months and sometimes occur just in advance of thunderstorms. Frontal winds may exceed 30 mph for several hours and reach peak speeds of more than 65 mph. Spring is the windy season, blowing dust and causing soil erosion. Winds predominate from the southeast in the summer and from the west in the winter, but local surface wind directions vary greatly because of the local topography.

Given the regional climate and meteorology, selection of an off-site disposal cell location would require evaluation of flooding potential, surface water bodies, groundwater aquifers, and erosive forces of wind. Extensive rock armoring, like that utilized on the existing Large Tailings Pile, would likely be necessary to minimize risk. In addition, high wind conditions could cause work to stop during excavation and transport of tailings, due to the potential for wind dispersion of particulates.

3.5 Groundwater

Groundwater resources are described in the following sections, including the groundwater conditions throughout the region around HMC-Grants. Site-specific investigations would be required for any locations identified as potential sites for an off-site disposal cell.

3.5.1 Hydrostratigraphy

Table 3-2 summarizes the hydrostratigraphy of the area. Significant aquifers in the region surrounding the HMC-Grants site include Quaternary alluvium along the Rio San Jose and San Mateo Creek, Quaternary alluvium-basalt sequences, Quaternary and Tertiary basalts, the Dakota-Zuni-Bluff aquifer, the Westwater Canyon aquifer, and the San Andres-Glorieta aquifer. These units provide yields of up to 1,110 gpm, 30 gpm, 100 gpm, and 2,830 gpm, respectively. Other aquifers present in the area but providing smaller yields include the Mesaverde Group sandstones, the Chinle Formation sandstones, the Entrada Sandstone, the Todilto Limestone, the Mount Taylor volcanics, and Quaternary and Tertiary basalts. These units generally yield less than one gpm to about 10 gpm.

Table 3-2. Summary of Hydrogeologic Units and Groundwater Quality

Era	Age	Group	Formation	Member	Hydrogeologic Unit	Water-Yielding Characteristics	Water Quality (TDS, mg/L)
Cenozoic	Quaternary		Alluvium		Quaternary alluvium and basalt sequences	Yields generally 5 to 10 gpm, up to 1,110 gpm in alluvium along Rio San Jose.	200 - 5,200
			Basalt				86 - 170
			Landslides			Insufficient data	Insufficient data
	Quaternary and Tertiary		Basalt		Quaternary and Tertiary basalts	Small yields generally to springs along margins of mesas; occasionally yields up to 100 gpm	86 - 260
			Mount Taylor Volcanics			Small yields generally to numerous springs along margins of mesas	Insufficient data
			Igneous Intrusives			Little to no yield	Insufficient data
Mesozoic	Cretaceous		Menefee Formation		Sandstones in the Mesaverde Group	Yields generally less than 10 gpm	140 - 550
		Mesaverde Group	Point Lookout Sandstone	Hosta Tongue		Yields 1 to 12 gpm	140 - 1,400
			Crevasse Canyon Formation	Gibson Coal Member			Insufficient data
				Dalton Sandstone Member			
				Dilco Coal Member			
			Gallup Sandstone				210 - 6,000
			Mancos Shale	Satan Tongue	Aquitard	Little to no yield	Insufficient data
				Mulatto Tongue			
				Lower Member			
			Dakota Sandstone		Dakota-Zuni-Bluff Aquifer	Yields up to about 30 gpm	280 - 1,390
	Jurassic		Morrison Formation	Jackpile Sandstone Member			Insufficient data
				Brushy Basin Member	Westwater Canyon Aquifer	Yields up to about 100 gpm	Insufficient data
				Westwater Canyon Member			280 - 2,000
				Recapture Member	Aquitard	Little to no yield	Insufficient data
			Zuni Sandstone		Dakota-Zuni-Bluff Aquifer	Yields up to 30 gpm	200 - 840
		San Rafael Group	Bluff Sandstone				Insufficient data
			Summerville Formation		Aquitard	Little to no yield	Insufficient data
			Todilto Limestone		Todilto-Entrada Aquifer	Generally yields 1 to 3 gpm	320 - 920
			Entrada Sandstone				320 - 710
	Triassic		Wingate Sandstone			Locally small yields from sandstone beds	250 - 3,000
			Chinle Formation	Petrified Forest Member	Sandstone beds in the Chinle Formation	Generally yields 0.5 to 10 gpm, but up to 300 gpm reported	170 - 18,000
				Monitor Butte member			
			Moenkopi Formation				
Paleozoic	Permian		San Andres Limestone		San Andres-Glorieta Aquifer	Yields up to 2,830 gpm	350 - 9,800
			Glorieta Sandstone				
			Yeso Formation	San Ysidro Member	Unnamed	Insufficient data	346 - 6,500
				Meseta Blanca Member			
			Abo Formation			Insufficient data	
Protero-zoic	Pre-cambrian		Undifferentiated rocks			Locally small yields from upper weathered zone and faults in the Zuni Mountains	80 - 250

3.5.2 Groundwater Occurrence

Groundwater occurs in permeable bedrock units and the overlying unconsolidated units throughout the area. Regionally, recharge to the groundwater system originates as precipitation falling on the land surface and infiltrating into the sediments and rocks, and groundwater flow is radially away from the Zuni Mountains. On the north side of the Zuni Mountains, groundwater flow through the bedrock units is generally northward into the San Juan structural basin, although some groundwater discharges locally to the Rio San Jose and the alluvial aquifer in the Rio San Jose valley.

As described in the updated CAP (HMC et al., 2012a), the HMC-Grants Site is located within the San Mateo Creek, Lobo Creek, and Rio San Jose drainages, The Lobo Creek is a tributary to the San Mateo Creek, which then drains to the Rio San Jose drainage. The San Mateo Creek drainage basin occupies approximately 240 square miles and includes the HMC-Grants Site. The Lobo Creek drainage area borders the eastern side of HMC-Grants and occupies approximately 56 square miles. The Rio San Jose drainage borders the western side of HMC-Grants and encompasses approximately 2,530 square miles (HMC et al., 2012a).

The City of Grants in Cibola County is within the Bluewater Underground Basin, under the jurisdiction of District 1 of the NMOSE. The shallow unconfined aquifer in the area (the alluvial aquifer) includes the Quaternary Alluvium and surficial volcanic flows. Deeper confined aquifers include those in the Chinle Formation (upper, middle, and lower aquifers) and a regional aquifer in the San Andres Limestone and the Glorietta Sandstone, In general, the San Andres Limestone and the Glorietta Sandstone are considered to be a single aquifer in the Grants area (HMC et al., 2012a).

The San Andres-Glorieta aquifer is the most prolific widespread aquifer in the region and is extensively used in the area. The San Andres Limestone consists of limestone with some sandstones and hosts solution channels, cavernous zones and fractures that transmit groundwater (Baldwin and Anderholm, 1992). The Glorieta Sandstone is composed of well-sorted, well-cemented, fine- to medium-grained sandstone. The aquifer crops out in a large area west of Grants, in the west-central and western parts of the area.

Recharge to the San Andres-Glorieta aquifer occurs by infiltration of precipitation and surface water in outcrop areas in the Zuni Mountains, leakage from Bluewater Lake and Bluewater Creek, and by infiltration through aquifer subcrops beneath Quyaternary basalt flows in the Malpais area. Groundwater flow is generally outward from recharge areas in the Zuni Mountains to discharge at springs, wells, leakage to adjacent rocks, and underflow out of the area and into the Rio Grande rift to the east (Baldwin and Anderholm, 1992). Through much of the area of concern, groundwater flow is toward the southeast, but west of the Continental Divide along the crest of the Zuni Mountains, flow is toward the west and southwest. Groundwater in outcrop areas can be under unconfined (water table) conditions, but where the aquifer is covered by younger rocks, the groundwater is under confined (artesian) conditions. Hydraulic conductivities range from relatively small, as low as 1 foot per day (ft/d) in the eastern part of the area, to large, up to approximately 1,500 ft/d in the Grants-Bluewater area.

Groundwater within the immediate vicinity of HMC-Grants has been well characterized and details are provided in the updated CAP and elsewhere (HMC et al., 2012a). Within the 30-mile radius of the Site, other hydrogeologic units include the Mesa Verde Group Sandstone, Dakota-Zuni Bluff Aquifer, Westwater Canyon Aquifer, Todilto-Entrada Aquifer, and Wingate Sandstone. Potential impacts to these aquifers and any others in the vicinity of a selected disposal cell location would need to be evaluated as part of the EIS process if tailings were to be relocated.

3.5.3 Groundwater Quality

Groundwater quality in the immediate vicinity of the HMC-Grants Site has been affected. Detailed investigations and ongoing monitoring have shown impacts to groundwater in the unconsolidated alluvial aquifer and in the upper and middle Chinle sandstone units beneath the alluvium. The Large Tailings Pile and Small Tailings Pile resulted over time in the contamination of groundwater with radioactive and non-radioactive constituents, including uranium, thorium-230, radium-226 and radium-228, selenium, molybdenum, vanadium, sulfate, nitrate, chloride, and total dissolved solids (TDS). Two plumes in the alluvial aquifer, the West plume and the South Felice Acres plume extended approximately 2½ miles from the site. The lateral extent of the West plume has been reduced over time with restoration program activities, and concentrations in the South Felice Acres plume have decreased. The continuing evaluation of the performance of the Grants restoration system, including the 2011 results (HMC et al., 2012c), shows that sulfate, TDS, chloride, uranium, selenium and molybdenum are still the key constituents of interest at this site. Successful restoration of ground water quality with respect to these key constituents will also accomplish restoration for other constituents. The monitoring program has shown that any low levels of nitrate, radium-226, radium-228, vanadium, and thorium-230 are also reduced when the key constituents are restored in a particular area.

Groundwater quality monitoring results and a performance review of the groundwater remediation system is provided in semi-annual and annual reports by HMC.

3.5.4 Groundwater Use

The on-line database of the New Mexico OSE provided records for approximately 2,550 water wells and 3,940 points of diversion (PODs) within 30 miles of the site (NMOSE, 2012). Reported well depths range from 10 ft to 3,700 ft and have a median of 175 ft, and reported depths to water range from 0 ft to 1315 ft and have a median of 90 ft. Most wells are registered for stock or domestic use, and these wells generally obtain water from the shallowest source with sufficient quantity and acceptable quality. Such supplies are obtained from virtually all of the hydrostratigraphic units described above.

The most heavily used aquifer in the immediate region is the San Andres-Glorieta. Water use in the Bluewater-Grants area peaked in 1956 at 14,210 acre-feet per year (af/yr) when 85 percent of the withdrawals from the aquifer were used for irrigation. Withdrawals for irrigation decreased when uranium ore was discovered in the area and land use changed to require less irrigation, and by 1986, pumpage had decreased to 3,900 af/yr (Baldwin and Anderholm, 1992).

Starting in 1986, Homestake paid for any home in Felice Acres, Broadview Acres, Murray Acres and Pleasant Valley Estates subdivisions to be supplied city water for residential use at the discretion of the homeowner. Since 2006, HMC paid for additional residential properties to be connected to the Village of Milan water system and NMED issued a health advisory to minimize the possibility of new wells being installed in the area. Residents still have the option to use groundwater for irrigation purposes or for watering livestock

3.6 Surface Water

3.6.1 Surface Water Resources

The area includes portions of seven hydrologic units, with the Rio San Jose unit (HUC* 13020207) covering the majority of the study area, and the other units comprising only a small portion of the study area, these include: Rio Puerco (HUC13020204), Arroyo Chico (HUC 13020205), North Plains (HUC 13020206), Chaco (HUC 14080106), Zuni (HUC 15020004), and Upper Puerco (15020006). Within approximately 30 miles from the HMC-Grants Site, there are approximately 2,400 miles of streams, of which approximately 2,100 miles are small headwater streams (first and second order) and approximately 280 miles of streams that are third order or larger (National Hydrography Dataset ([NHD], USGS, 2012). Of the third order and larger streams, approximately 70 miles are considered perennial and 210 miles are considered intermittent. The main streams in the area include Acoma Creek, Arroyo del Puerto, Arroyo Leon, Bluewater Creek, Canada Marcelina, Cebolitta Creek, Cottonwood Creek, Mitchell Draw, Rio San Jose, San Isidro Arroyo, San Mateo Creek, San Miguel Creek, and Voght Draw (NHD, 2012). Bluewater Lake is the only sizeable lake in the area; it covers approximately 1,200 acres.

The Rio San Jose is one of the most prominent streams in the area, flowing to the southeast and roughly following Interstate 40. It empties into Rio Puerco in Valencia County, which then empties into the Rio Grande in Socorro County.

3.6.2 Surface Water Quality

None of the main surface water bodies listed above (Section 3.6.1) appears on the 303(d) list of impaired surface waters for the State (NMED, 2012a). There is a fish consumption advisory at Bluewater Lake due to elevated levels of mercury in tiger muskie. The advisory calls for limiting consumption of tiger muskie that are greater than 30 inches to three meals per month (assuming 8 ounces per meal, pre-cooked weight) (NMED, 2012b).

3.6.3 Surface Water Contamination

No surface water contamination has been reported the HMC-Grants Site. The potential to contaminate surface water at an off-site disposal cell location would need to be evaluated during a siting study and EIS. The possibility of accidents along proposed transport routes would also need to consider potential to impact surface water.

3.6.4 Surface Water Use

All perennial waters, not otherwise classified by the State, are designated for warmwater aquatic life, livestock watering, wildlife habitat, and primary contact. All intermittent waters are designated for marginal warmwater aquatic life, livestock watering, wildlife habitat, and primary contact.

The Rio San Jose in Cibola County has the following designated uses as a tributary to the Rio Grande (under State of New Mexico Standards 20.6.4.109 NMAC, State of New Mexico, 2011): coldwater aquatic life, domestic water supply, fish culture, irrigation, livestock watering, wildlife habitat, and primary contact.

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* HUC = Hydrologic Unit Code, as defined by the USGS.

Surface water use at an off-site disposal cell location would need to be evaluated to prevent unintended adverse consequences of a disposal cell construction.

3.6.5 Surface Water Quality Criteria

Standards for interstate and intrastate surface waters were published by the New Mexico Water Quality Control Commission January 14, 2011, and approved by EPA April 18, 2011 (State of New Mexico, 2011). The standards include numeric criteria for existing, designated, and attainable uses. Uses include domestic water supply, irrigation, livestock watering, human consumption of aquatic organisms, wildlife habitat, and protection of aquatic life.

Surface water standards from the State of New Mexico are presented in Table 3-3 for those constituents that are identified as groundwater quality constituents of concern at the HMC-Grants Site (Section 2.1)

Table 3-3. Surface Water Standards

Constituent	Domestic Water Supply	Irrigation	Livestock Watering	Wildlife Habitat	Acute Aquatic Life	Chronic Aquatic Life	HH-OO
Selenium, dissolved (ug/L)	50	b	50				4,200
Selenium, total recoverable (ug/L)				5	20	5	
Uranium, dissolved (ug/L)	30						
Molybdenum, dissolved (ug/L)		1,000					
Molybdenum, total recoverable (ug/L)					7,920	1,895	
Sulfate (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Chloride (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
TDS (mg/L)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Nitrate as N (mg/L)	10		*	*			*
Vanadium, dissolved (ug/L)		100	100	*			*
Thorium-230 (pCi/L)		*	*	*			*
Ra-226+Ra-228 (pCi/L)		*	*	*			*

*Site standards were deemed not necessary for these constituents in groundwater, so they were not included for surface water.

HH-OO = Human health ingestion of organisms only.

(a) Standards are not available for the study area. Standards are available only for selected reaches of major river basins in New Mexico.

3.7 Floodplains

Based on current mapping available from the Federal Emergency Management Agency (FEMA) (2012), floodplains are present in limited areas along stream channels in the region. Consequently, a detailed hydrologic assessment, including delineation of potential floodplains and evaluation of potential flood-related issues, would need to be conducted for any area being considered as a potential off-site disposal cell location. A similar assessment would be required for any transportation corridors between the existing site and a potential off-site disposal cell location. Any potential off-site disposal cell location should avoid mapped flood-prone areas. Flood protection may be possible for related infrastructure such as transportation corridors.

3.8 Wetlands

National Wetland Inventory (NWI) digital data are not currently available from the U.S. Fish and Wildlife Service (USFWS) for the area around Grants, New Mexico; however, general information is available from the USGS's National Land Cover Database (NLCD). Within approximately 30 miles from the HMC-Grants Site, there are approximately 463 acres are classified as woody wetlands and approximately 509 acres are classified as emergent herbaceous wetlands (NLCD, 2006). There are approximately 2,300 acres of open water (NLCD, 2006).

A wetland delineation would need to be conducted to determine whether there are jurisdictional wetlands or waters of the U.S. (WoUS) within the footprint of an off-site disposal cell location. Additional delineation would be needed for any wetlands or stream crossings that would be impacted along the transportation route between the HMC-Grants Site and an off-site disposal cell location.

Depending on the areal extent of the impacts to wetlands or WoUS, a nationwide permit (NWP) or an individual permit may be required from the Albuquerque District of the U.S. Army Corps of Engineers (Corps). The Corps may also require a pre-construction notice (PCN) before initiating any construction activities that would impact jurisdictional wetlands or WoUS. Coordination on wetland impacts would also need to be conducted with the State, including the New Mexico Wetlands Program, NMED, and the Surface Water Quality Bureau, NMED, for Section 401 Water Quality Certification for NWPs. Additional coordination may be required with Cibola or McKinley County (or other counties depending on the location of an off-site disposal cell).

3.9 Aquatic Ecology

Within Cibola and McKinley Counties there are no fish or other aquatic species that are on the federal list of endangered or threatened species. However, there is one federal candidate fish species – the Zuni bluehead sucker (see Table 3-4). This fish species is also on the New Mexico list of endangered and threatened species where it is listed as endangered in Cibola and McKinley Counties. The recovery plan for this species indicates that its current distribution in New Mexico is limited to the Rio Nutria drainage upstream of the Nutria Box Canyon this includes the Rio Nutria, Tampico Draw, and Agua Remora (NMDGF, 2004). All of these streams are in the Cibola National Forest and Zuni Indian Reservation.

The State also lists the roundtail chub as endangered in McKinley County (Table 3-4). Its historical range in McKinley County was in the Zuni River (NMDGF, 2006). Aquatic ecology would need to be fully evaluated for an off-site disposal cell location, to prevent unintended adverse consequences from disposal cell siting/construction and transport of tailings.

Table 3-4. Federal and State Threatened and Endangered Species in Cibola and McKinley Counties

Species Common Name (1)	Scientific Name	Status (2)	County
Mammals			
Spotted bat	*Euderma maculatum*	ST	Cibola
Arizona montane vole	*Microtus montanus airzonensis*	SE	McKinley
Birds			
Mexican Spotted Owl	*Strix occidentalis lucida*	FT	Cibola, McKinley
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	FE, SE	Cibola, McKinley
Yellow-billed Cuckoo	*Coccyzus americanus*	FC	Cibola, McKinley
Bald Eagle	*Haliaeetus leucocephalus alascanus*	ST	Cibola, McKinley
Peregrine Falcon	*Falco peregrinus anatum*	ST	Cibola, McKinley
Gray Vireo	*Vireo vicinior*	ST	Cibola, McKinley
Costa's Hummingbird	*Calypte costae*	ST	McKinley
Least Tern	*Sterna antillarum athalassos*	ST	McKinley
Fish			
Zuni Bluehead Sucker	*Catostomus discobolus yarrowi*	FC, SE	Cibola, McKinley
Roundtail Chub	*Gila robusta*	SE	McKinley
Plants			
Pecos Sunflower	*Helianthus paradoxus*	FT, SE	Cibola
Zuni Fleabane	*Erigeron rhizomatus*	FT, SE	Cibola, McKinley
Parish's Alkali Grass	*Puccinellia parishii*	SE	Cibola, McKinley

(1) Sources: BISON-M 2012. NHNM 2012.
(2) FC = Federal Candidate; FE = Federal Endangered; FT = Federal Threatened; SE = State Endangered; ST = State Threatened

3.10 Terrestrial Ecology

3.10.1 Species Listed in Threatened and Endangered Species Act That May Be Present in the Vicinity of Grants

Within Cibola and McKinley Counties there are four terrestrial species of plants and animals that are on the federal list of endangered or threatened species (see Table 3-4). This includes two bird species - the southwestern willow flycatcher (endangered) and the Mexican spotted owl (threatened), and two plant species – the Pecos sunflower (threatened) and Zuni fleabane (threatened). There is also one federal candidate bird species – the yellow-billed cuckoo (BISON-M, 2012).

In the region, there is designated critical habitat for the Mexican spotted owl (192,867 acres) and the Pecos sunflower (88 acres). The areas of critical habitat for these species are shown on Figure 3-3.

Additional evaluation would need to be conducted to determine whether any of these species occur within the area that would be affected by the off-site disposal cell alternative. Evaluation of potential impacts to these species would require coordination with the U.S. Fish and Wildlife

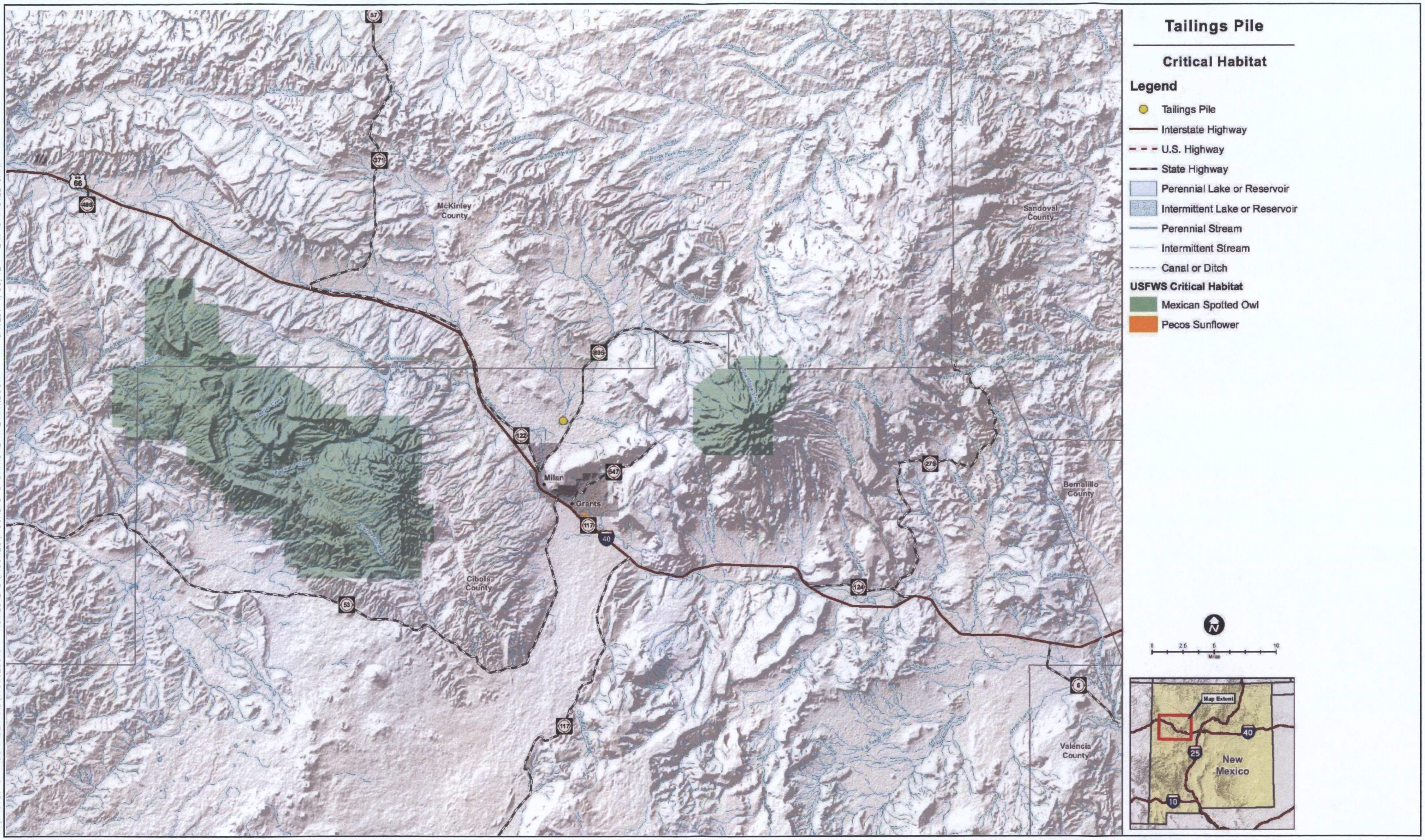
Service. If potential impacts are projected then measures would need to be taken to avoid or minimize impacts to the extent possible, and to mitigate for unavoidable impacts. Potential impacts to an endangered or threatened species on federal land could require preparation of a Biological Assessment (BA) for review by USFWS, and impacts to a species on private lands could require development of a Habitat Conservation Plan (HCP).

3.10.2 Terrestrial Vegetation and Wildlife

The major vegetation types within the region are shrub/scrub, evergreen forest, and grassland/herbaceous. Within approximately 30 miles from the HMC-Grants Site, shrub/scrub occupies 780,000 acres, evergreen forest occupies 698,000 acres, and approximately 262,000 acres are grassland/herbaceous (NLCD, 2006). Other minor components of the terrestrial vegetation within the area include: barren land, deciduous forest, cultivated crops, and mixed forest. Approximately 14,300 acres are classified as Developed (NLCD, 2006).There are significant amounts of pronghorn, mule deer, and elk habitat within the region. GIS maps from the New Mexico Department of Game and Fish indicate the locations of "crucial habitat" for these species. Approximately 187,200 acres of crucial pronghorn habitat occurs in the northeast and southwest portions of the area. Crucial mule deer habitat includes two main areas (approximately 758,400 acres), roughly corresponding to units of the Cibola National Forest, that occur on the northeast and southwest sides of Interstate 40. A wide travel corridor of approximately 251,400 acres connects these two areas by crossing Interstate 40 (from approximately San Rafael to Continental Divide), and also encompasses the HMC-Grants Site and surrounding area. The total area of mule deer habitat around HMC-Grants comprises approximately 1,010,000 acres.

There are large areas of crucial elk habitat (approximately 833,300 acres) on the northeast and southwest sides of Interstate 40 with two travel corridors (approximately 81,800 acres) connecting the two areas by crossing Interstate 40. The crucial elk habitat on the northeast side of Interstate 40 encompasses the HMC-Grants Site and surrounding area. The total area of crucial elk habitat around HMC-Grants is approximately 915,100 acres; the distribution of crucial elk habitat is similar to the mule deer.

Potential environmental impacts on federal land could trigger compliance with the National Environmental Policy Act (NEPA), which would likely require preparation of either an Environmental Assessment (EA) or an EIS. This requirement would delay the start of any relocation while the appropriate studies are completed, usually a period of several years. The environmental impacts of leaving the large tailings pile in its current location have been studied and found to be acceptable as no further impacts to vegetation or habitat are likely. Permanent capping and closure of the large tailings pile at its current location will not impact wildlife or vegetation in the area.



Project No. 1159520013

April 2012

Figure 3-3
Potential Critical Habitat Map

3.10.2.1 Other Federal and State Lands within the Study Area

In addition to the wildlife habitat in the Cibola National Forest, discussed above, there are other federal and state lands in the area that include wildlife habitat. El Malpais National Monument, operated by the National Park Service, is located along Highway 53 to the south of the HMC-Grants Site. It encompasses 114,277 acres. The lower elevations of the park are dominated by pinon-juniper forest, while ponderosa pine and Douglas fir occur in the higher elevations. Mammalian wildlife includes black bear, mountain lion, coyote, foxes, pronghorn, elk, and deer. More than 200 species of birds have been recorded in the area. The park also provides habitat for rattlesnake, gopher snake, lizards, and other reptiles (NPS, 2012).

El Malpais National Conservation Area is located adjacent to El Malpais National Monument and is administered by the Bureau of Land Management (BLM). It comprises 231,230 acres and includes the West Malpais and Cebolla Wilderness Areas which collectively cover approximately 100,000 acres. The environment is semi-desert, with annual precipitation averaging 10 inches. The main vegetation classes are grass-shrub, pinon-juniper, and ponderosa pine (BLM, 2001). Wildlife includes a variety of mammals, birds, reptiles, and amphibians. Mammals in the West Malpais Wilderness Area include pronghorn, mule deer, mountain lion, rabbits, and squirrels. Birds nesting in the Cebolla Wilderness Area include golden eagle, prairie falcon, red-tailed hawk, and great horned owl.

Bluewater State Park, operated by the New Mexico State Parks Division, is located west of I-40. It comprises 4,200 acres, including 1,200 acre Bluewater Lake, and 3,000 acres of land. The lake is surrounded by pinon-juniper woodland and is stocked with rainbow trout, cutthroat trout, and catfish. Common mammals observed in and around the park include mule deer, coyote, fox, skunk, and squirrel. Sixty-eight species of birds have been recorded in the park. Bald eagle and peregrine falcon have been reported at Bluewater Lake (NMSPD, undated).

3.10.3 Other Special Status Species

There are eight terrestrial wildlife species and three plant species in Cibola and McKinley Counties that are on the State list of endangered and threatened species (NHNM, 2012) (Table 3-4). This includes two mammals – the spotted bat (threatened) and Arizona montane vole (endangered), and six bird species – southwestern willow flycatcher (endangered), bald eagle (threatened), peregrine falcon (threatened), gray vireo (threatened), Costa's hummingbird (threatened), and least tern (threatened). The plant species are the Pecos sunflower (endangered), Zuni fleabane (endangered), and Parish's alkali grass (endangered). Potential impacts to State-listed species would require coordination with the New Mexico Department of Game and Fish.

In addition to endangered and threatened species, there are designations used by other federal agencies to indicate that species have special status, but that do not offer special legal protection such as under the Endangered Species Act (ESA), these include the U.S. Forest Service "Sensitive" species and BLM "Sensitive" species. These species are listed in Table 3-5. Potential impacts to these species would need to be addressed if the off-site disposal cell alternative would be located on or affect U.S. Forest Service or BLM land; the species requiring evaluation would be dependent on their occurrence within the potentially affected area.

3.11 Land Use

The following subsections discuss land use impacts associated with the off-site disposal cell alternative.

3.11.1 Construction and Operations Impacts at the Proposed Off-Site Location

Impacts to land use would include potential changes to existing land use at the off-site disposal cell alternative location or at nearby properties. The current land may include forests, agricultural land, land used for grazing, and oil and gas and mineral extraction. The several hundred acres needed for the off-site disposal cell construction area would be transferred to DOE in perpetuity. All surface and subsurface land uses would be vested with DOE. Any current land permits would be vacated from the current permittee. An off-site disposal cell in any location would create a long-term loss of all grazing rights and oil and gas and mineral extraction in perpetuity. This would create a long-term loss of revenue for any surface or subsurface permits or leases on the site.

All three options for transportation to an off-site disposal cell location would require a permanent access road and land for associated infrastructure. About 40 acres of land would be required for the truck haul option transportation infrastructure. For a rail haul option, approximately 69 additional acres would be needed to construct new rail spurs, a transfer station, and haul roads. Wherever possible, a slurry pipeline would be constructed in the existing pipeline right-of-way or along any road rights-of-way. However, approximately 24 acres would be disturbed for a transfer station. For a slurry pipeline, some truck haul roads would still be needed, and the associated impacts would still exist because not all materials could be transported by slurry pipeline to the off-site location for final disposal and must be transported by other means. Land disturbance for the slurry pipeline would be short-term because the property allocated for such use would be reclaimed once relocation of the tailings pile was complete and the disposal cell was capped.

Table 3-5. Other Special Status Species in Cibola and McKinley Counties

Species Common Name (1)	U.S. Forest Service Sensitive Species (2)	BLM Sensitive Species (3)	County
Mammals			
Townsend's Big-Eared Bat	X	X	Cibola
Little Brown Bat	X	X	Cibola, McKinley
Big Free-tailed Bat		X	Cibola
Fringed Myotis		X	Cibola, McKinley
Long-eared Myotis		X	Cibola, McKinley
Long-legged Myotis		X	Cibola, McKinley
Small-footed Myotis		X	Cibola, McKinley
Yuma Myotis		X	Cibola
Spotted bat	X	X	Cibola
Gunnison's Prairie Dog	X		Cibola, McKinley
Botta's Pocket Gopher	X		Cibola, McKinley
Ceboletta Pocket Gopher	X	X	Cibola
Northern Pocket Gopher	X		Cibola
Ringtail	X		Cibola, McKinley
Merriam's Shrew	X		McKinley
Crawford's Desert Shrew	X		Cibola
Dwarf Shrew	X		Cibola
White Mountains Ground Squirrel	X		Cibola
Long-tailed Vole	X		Cibola, McKinley
Navajo Mogollon Vole	X		McKinley
Birds			
American Bittern	X		Cibola, McKinley
Gray Catbird	X		Cibola
Least Tern	X		McKinley
Black Tern		X	McKinley
Long-billed Curlew	X		Cibola, McKinley
Northern Goshawk	X	X	Cibola, McKinley
Ferrugionous Hawk	X	X	Cibola, McKinley
Swainson's Hawk	X	X	Cibola, McKinley
White-faced Ibis	X	X	Cibola, McKinley
Belted Kingfisher	X		Cibola, McKinley
Osprey	X		Cibola, McKinley
Burrowing Owl	X	X	Cibola, McKinley
Flammulated Owl	X		Cibola, McKinley
Mexican Spotted Owl	X		Cibola, McKinley
Southwestern Willow Flycatcher	X		Cibola, McKinley
Yellow-billed Cuckoo	X		Cibola, McKinley
Blue-throated Hummingbird	X		McKinley
Costa's Hummingbird	X		McKinley
Bald Eagle	X		Cibola, McKinley
Great Egret	X		McKinley
Snowy Egret	X		McKinley
Peregrine Falcon	X		Cibola, McKinley
Mountain Plover	X		Cibola, McKinley
American Redstart	X		Cibola
Gray Vireo	X		Cibola, McKinley
Loggerhead Shrike	X	X	Cibola, McKinley
Sora	X		McKinley
Black-necked Stilt	X		McKinley
Reptiles			
Texas Horned Lizard	X	X	Cibola
Desert Kingsnake	X		Cibola
Amphibians			
Northern Leopard Frog	X		Cibola, McKinley
Fish			
Rio Grande Chub	X		Cibola
Zuni Bluehead Sucker	X	X	Cibola, McKinley
Rio Grande Sucker	X		Cibola
Roundtail Chub			
Plants			
Pecos Sunflower			
Zuni Fleabane			
Parish's Alkali Grass			

(1) BISON-M 2012
(2) U.S. Forest Service Region 3
(3) BLM New Mexico State Office

3.11.2 Construction and Operations Impacts Related to Transportation

Under the truck haul option, trucks would use any existing roadways between the HMC-Grants Site and the off-site disposal cell location. However, additional roadways may need to be constructed if the off-site disposal cell were to be located in an area without roadways in-place. Construction of roads will adversely affect local traffic, air quality, and noise levels and will limit land use of the areas used for the roads, for at least the duration of construction and tailings relocation.

There is an existing rail line along I-40 southwest of the site. Construction and operation of a rail spur from the HMC-Grants Site to this line and a rail line to the designated off-site disposal cell could be required, or a new rail line could be constructed directly to the off-site disposal cell location. Any rail line construction will have an adverse impact to local traffic and noise levels, as well as having adverse effects on air quality from emission of both particulates and fossil fuels. Construction of rail line will limit land use of the areas used for the rails, for at least the duration of construction and tailings relocation.

Noise and vibration would occur above background levels as a result of transporting the tailings, cover materials, and impacted soils by truck or rail and could disturb residents, businesses, and recreational users along the travel routes and affect current uses of those properties. Traffic disruptions could occur as a result of increased truck traffic and adversely affect residents, businesses, and recreational users along the travel routes.

The slurry pipeline route from the HMC-Grants Site ("origin" site) to the designated off-site disposal cell area ("terminal" site) would likely be within lands administered by BLM. The pipeline could be located in an existing right-of-way to the extent possible or in a right-of-way parallel to the existing right-of-way. Use of an existing right-of-way would not adversely affect existing land use; use of a corridor parallel to the existing right-of-way would cause minor, short-term land use impacts. However, it is possible that the right-of-way could involve Reservation lands that may not be readily available for use, would require additional permits for use, or could have cultural impacts that would need to be addressed. When the project was completed, the pipeline would have to be removed and the land returned to its original condition. This would include a baseline and closure radiation survey of the length of pipeline.

In addition, truckloads of borrow material to backfill the tailings pile footprint and close the HMC-Grants Site would be needed. It is estimated that 36 truckloads of material per day would be needed to transport the materials, and that it could take 4.5 years to transport the needed materials to the site.

3.12 Cultural Resources

This section addresses the potential for disturbance of known cultural resources or the discovery of unknown resources associated with the off-site disposal cell alternative.

3.12.1 Cultural History or Resources near Grants

Cultural sites included in the National Register of Historic Places could be adversely affected by construction and operations at the off-site disposal cell location and along the transportation route. A Class III cultural resource survey would need to be conducted and would indicate the precise number and types of cultural sites present. Along with the Class III survey, a site-specific study would need to be conducted to identify potential traditional cultural properties that may exist at the selected disposal cell location.

DOE, BLM, the State Historic Preservation Officer, affected Native American tribes, and the Advisory Council on Historic Preservation would determine appropriate mitigation measures (if needed) through the Section 106 consultation process. Mitigation measures might include (1) avoiding the cultural resource sites, (2) monitoring the cultural resource during surface-disturbing activities, (3) excavating and recording cultural resource data before construction activities began, or (4) moving cultural resource objects from areas of disturbance to nearby undisturbed areas.

Cultural resources located near areas of disturbance could be adversely affected indirectly (through illicit collection, vandalism, or inadvertent destruction) as a result of increased human activity in the area. If the off-site disposal cell alternative were to be implemented, workers would be required to receive training on the need to protect cultural resources and the legal consequences of disturbing cultural resources.

3.12.2 Applicable Regulations

The following state and federal regulations may be applicable to cultural resources potentially affected by the off-site disposal cell alternative.

- New Mexico Cultural Properties Protection Act of 1969
- New Mexico Prehistoric and Historic Sites Preservation Act of 1993
- New Mexico Cultural Properties Preservation Easement Act
- New Mexico Historic Districts and Landmark Act of 1965
- Disturbing a Marked Burial Ground
- Antiquities Act of 1906
- American Indian Religious Freedom Act of 1978
- Archeological Resources Protection Act of 1979 (16 USC 470aa-mm)
- Historic Sites Act of 1935
- National Environmental Policy Act of 1969
- National Historic Preservation Act of 1966
- Native American Graves Protection and Repatriation Act of 1990 (43 CFR Part 10)
- National Register of Historic Places (36 CFR Part 60)
- Preservation of American Antiquities (43 CFR Part 3)
- Protection of Archeological Resources (43 CFR Part 7)
- Protection of Historic Properties (36 CFR Part 800)

The above information should not be construed as a comprehensive list, but provides a summary of some of the regulations that may be applicable.

3.13 Noise and Vibration

The Occupational Safety and Health Administration (OSHA) and EPA define noise as unwanted or disturbing sound (OSHA 2012, EPA, 2012b). Sound becomes unwanted when it either interferes with normal activities such as sleeping or conversation, or diminishes one's quality of life. The persistent and escalating sources of sound can often be considered an annoyance, and it can have health consequences. Although the federal government passed the Noise Control Act of 1972 (42 USC §4901 et seq., 1972) to be administered by the EPA, responsibility for its enforcement was later delegated to state and local authorities. However, EPA or a designated federal agency regulates noise sources, such as rail and motor carriers, low noise emission products, construction equipment, transport equipment, and trucks.

The OSHA standard for daily permissible noise exposure is 90 decibels for an eight-hour day. The National Institute of Occupational Safety and Health (NIOSH) has slightly more conservative standards (Table 3-6). The level of sound expected from the various equipment and machinery that would be used to excavate and relocate the Large Tailings Pile, as well as to construct a new off-site disposal cell, would approach some limits. It is likely that the construction noise could be considered objectionable, would impact wildlife and would last for several years. Vibration for the excavation and construction work as well as transport is likely to be at noticeable levels. Figure 3-4 shows levels of pressure and decibels associated with common exposures.

Table 3-6. Typical Decibel Levels of Common Exposures

Decibels (dBA)	Permissible Hours Per Day of Exposure		Sound Level Produced by Machinery	Expected Use at HMC-Grants Site or Off-Site Disposal Cell
	OSHA	NIOSH		
85	--	8	Heavy city traffic	Yes
86	--	6	Forklift, Hammer (87-95 dBA)	Yes
88	--	4	Earthmover (87-94 dBA)	Yes
89	--	3	Backhoe (84-93 dBA)	Yes
90	8	2	Train whistle, truck traffic	Yes
92	6	1.5	Front end loader (86-94 dBA)	Yes
94	--	1	Crane (90-96 dBA)	Yes
95	4	--	Jack hammer at 50 feet	Yes, at relocation site
97	3	0.5		
100	2	0.25	Stud Welder, bulldozer	Yes
102	1.5	--	Jackhammer (102-111 dBA)	Yes, at relocation site
105	1	--		
110	0.5	--	Power saw	Yes
112	--	0		
115	0.25 or less	--	Pneumatic Riveter	

Sources: OSHA 2012; Center to Protect Workers' Rights 2012.

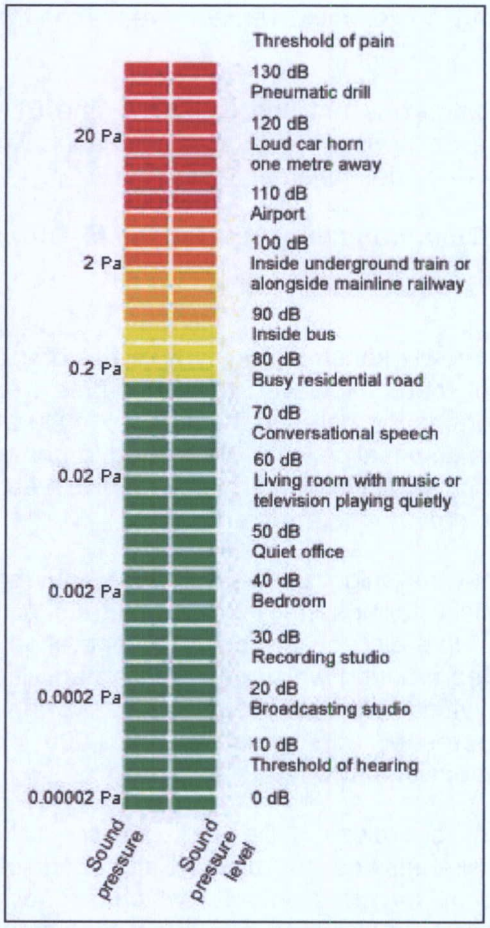


Figure 3-4. Typical Sound Pressure and Decibel Levels of Common Exposures (OSHA, 2012)

3.14 Visual Resources

This section describes the impacts to the physical features of the landscape that impart scenic value in the region affected by the off-site disposal alternative. The impacts would be imposed on viewers who live in, work in, or visit an area and can see ongoing human activities or the results of those activities.

3.14.1 Construction and Operations Impacts

Construction and operations at the off-site disposal cell location would have unknown adverse effects on visual resources, since the site has yet to be selected. However, adverse effects to visual resources could be observed from travelers on I-40 and other local roads, local towns, such as Grants, Milan, Prewitt, San Rafael, and McCartys, and from visitors in the Cibola National Forest

One potential adverse impact from disposal cell construction would be from the lighting used during dawn and dusk hours (and at nighttime under a double-shift work scenario) during the construction period. This impact would be expected to be minor, as shielded night lighting could be used to minimize glare. However, it could disturb wildlife. Less lighting would be used after disposal cell construction, but some could remain even after the disposal cell is closed for security purposes.

Because a disposal cell location has not been selected, the BLM class for visual resources cannot be determined. However, a visual resources evaluation would need to be completed if the off-disposal alternative were to be implemented.

3.14.2 Construction and Operations Impacts Related to Transportation

3.14.2.1 Truck Haul

Under the truck haul option, newly constructed roads to the off-site disposal location could be visible to travelers on current roads. However, these features would not draw the attention of most travelers as they are common features in the modern, culturally modified landscape. Once the construction of the off-site disposal cell was completed, a portion of the access road may be expected to be removed and reclaimed. After three to five years of vegetation growth, the former location of this feature may not be apparent.

The number of trucks per hour that might use I-40 and the haul road to the off-site area on any given day to transport materials (tailings, borrow material, and vicinity property material) would vary, probably significantly, depending on the phase of operation and other factors during the approximately three to five years during which construction activities would occur and 10 years for tailings transportation activities. Table 3-7 reports a total of approximately 550,000 material shipments, which would represent approximately 1,100,000 one-way trips, conservatively assuming that all shipments consist of two legs.

For the truck transport option, regardless of the work shift scenario, it is estimated that it would require approximately six trucks per hour to transport all materials. This increase in truck traffic may or may not be noticed by travelers on I-40, which already is a primary trucking route. Because truck traffic is currently pervasive on I-40, the visual impacts of the potential additional traffic would be negligible for I-40 travelers. For travelers on other roads, the addition of six trucks per hour would have minimal visual impacts. The additional truck traffic would create moderate to strong contrasts (depending upon the amount of motorized recreational traffic present) in movement and would draw attention to the project. These impacts would be short-term (approximately 10 years) only.

For the general public, this transportation option would be compatible with BLM's Class III visual resource objectives. For the local residents and recreationists who travel Blue Hills Road, this transportation option would not be compatible with Class III objectives during the three- to five-year period of disposal cell construction.

Table 3-7. Truck Transportation Quantity Estimates

Item	Unit	Value
Material to be Removed	tons	22,000,000
Tons per Truck	tons/load	40
Years to Complete	years	10
Quantity per year	tons/year	2,200,000
Truckloads per year	loads/year	55,000

Item	Unit	Value
Roundtrip Distance to Off-site Disposal Location	miles/load	60
Miles traveled per year	miles/year	3,300,000
Gallons of fuel consumed, per year @ 6 mpg	gallons/year	550,000
Weeks of operation per year	weeks/year	52
Truckloads per week	loads/week	1,058
Days operating	days/week	7
Truckloads per day	loads/day	151
Average roundtrip truckloads per day	loads/day	4
# of Trucks	trucks	40
# of Drivers Required	drivers	60

3.14.2.2 Rail Haul

Under the rail haul option, the newly constructed railroad spur would be visible to travelers on I-40 and other current roads. As under the truck haul option, this feature would not draw the attention of most travelers, as it is a feature commonly found along highways. The train/truck transfer station that may be constructed under this option would draw the attention of local residents and recreationists traveling along current recreational pathways. The station may or may not be visible to travelers along other routes. The station's buildings and associated equipment may create a strong contrast with the surrounding natural landscape. The movement of haul trucks would also create moderate to strong contrast, and these adverse impacts would occur throughout the construction and transportation period. Once the relocation was completed, rail and haul truck traffic would cease, the station would be dismantled, and the station area would be reclaimed with native vegetation. After three to five years of vegetation growth, the visual impact would likely be eliminated. Because the station and rail and truck traffic would create a strong visual contrast for travelers on current roads, this transportation option would not be compatible with BLM's Class III visual resource objectives during the construction and transportation period. However, Class III objectives would be met once the station was dismantled.

3.14.2.3 Slurry Pipeline

Under the slurry pipeline option, adverse visual resource impacts would occur during pipeline construction and for approximately three to five years afterward, during revegetation of the corridor. After transportation of the tailings was completed, the pipeline would be removed, again disturbing the land and creating adverse visual impacts. The primary viewers of the pipeline corridor would be travelers along roads near the pipeline corridor. The pipeline construction may contrast moderately to severely with the surrounding features, some of which are linear and barren of vegetation and some of which are complex, rugged, or vegetated. After vegetation was established along the corridor, the contrast would be weak or nonexistent. The BLM class visual impacts associated with construction of the pipeline cannot be known until the relocation site is determined. After vegetation was established along the corridor, the contrast between the corridor and surrounding landscape would be moderate to nonexistent, depending upon the success of revegetation. However, the pipeline would be removed after the tailings relocation is complete, and the visual disruption would occur again until revegetation takes place.

3.14.3 Impacts from All Sources

Moving the tailings pile from the HMC-Grants Site to an off-site disposal cell location under any transportation option would have both short-term, adverse visual impacts and significant long-term adverse visual impacts. The amount of land that would be disturbed in the creation of a new disposal cell and transportation route would be extensive and the increased traffic and activity associated with construction and tailings relocation would be significant.

3.15 Infrastructure

3.15.1 Waste Management

The waste management infrastructure supporting the off-site disposal cell alternative would consist of wastewater disposal and non-radioactive solid waste disposal. The extent of infrastructure to be constructed depends on the type of transportation selected and the expected number of employees that would be working at the off-site disposal cell facility.

Non-radioactive solid waste from the off-site disposal cell facility would be collected by a designated contractor at a pre-determined frequency and transported to a local waste handling facility. Recycling services would likely be used as available by the designated contractor. An alternative possibility is to dispose of all solid waste within the off-site disposal cells.

Wastewater disposal methods would depend on the number of employees working at the site on a full-time basis. Disposal options may include portable toilets, leach-field, septic system or other types of permanent bathroom facilities constructed at the off-site disposal site.

3.15.2 Electrical Power Supplies

The remoteness of the off-site disposal cell location and the type of transportation mode selected would play a large role in determining the infrastructure required to supply electrical power to the disposal cell location. New overhead power lines and/or electrical substations would likely need to be constructed to bring electric service to the off-site disposal cell location.

The Continental Divide Electric Cooperative (CDEC) located in Grants, New Mexico, is a consumer-owned electric distribution co-op providing electrical service throughout Cibola County and parts of McKinley County. The CDEC is the primary electric utility service provider within the counties, and would likely be the primary service provider for the off-site disposal cell location if it is within a 30 mile radius of the HMC-Grants Site. The cost of electric power supply infrastructure could only be determined after the final selection of the off-site disposal cell location.

3.15.3 Water

Potable water would be provided to the off-site disposal cell location by a pipeline or a designated contractor if no clean water supply is available at the site. Non-potable water may be obtained at the off-site disposal cell location depending on availability and quality. The cost of water infrastructure (e.g. storage tanks, pipelines) would be dependent on site location and availability of water resources at that location.

3.16 Transportation

This section summarizes potential impacts to traffic in the area that would be affected by the off-site disposal alternative. In the following discussions, estimated percent increases in traffic are based on increases over the 2004 Annual Average Daily Traffic (AADT) for all vehicles or for trucks on segments of Interstate 40 published by New Mexico Department of Transportation (NMDOT). The subsections below describe transportation impacts from truck, rail, and slurry pipeline options for tailings relocation. Under each scenario, the required annual monitoring and maintenance activities at the site would result in minimal increases in traffic volumes.

3.16.1 Truck Transportation

Implementation of this alternative would increase area traffic as a result of construction and operations at the HMC-Grants Site, transport of tailings from the HMC-Grants Site to the off-site disposal location, and transport of borrow materials from borrow areas to the HMC-Grants Site and the off-site disposal location. Vehicular quantities and costs associated with truck transportation are included in Table 6-6 and further discussed in Section 6.3.2.9.

There would be initial short-term (period of several months) increases in area traffic on I-40, Highway 605, and other relevant roads while preparations took place at the HMC-Grants Site and at the off-site disposal location. These activities would include bringing heavy equipment, such as backhoes, graders, front-end loaders, bulldozers, and trucks to the sites and constructing secure stockpile areas for various materials to be used during the construction of process areas, infrastructure, or buildings (e.g., diesel fuel, water for dust control). In addition, a variety of construction trades would need to access the sites to set up temporary field offices and prepare road access areas. These activities would add to area traffic and could result in minor congestion and inconveniences near the site entrance on Highway 605 and adjoining roads, such has I-40.

Workers would commute to the HMC-Grants Site for jobs at the site, transport of tailings, and transport of material from borrow areas. The estimated average number of vehicle trips associated with these workers could increase daily traffic in the area by an estimated 314 vehicle trips per day. Transportation-related workers would also commute to jobs. There would also be miscellaneous trips for supplies and meals. This estimate is based on the assumption that that the maximum number of transportation workers (truck option) would be needed and that all workers (on-site or transportation-related) would need to traverse I-40 to access the HMC-Grants Site and the off-site disposal cell location. It is more likely that some workers, possibly one-half of the work force, would come from Grants or other local townships, and that some workers would car-pool. In addition, assuming a double-work shift, approximately half of these trips would occur at times of the day when traffic volumes are typically lower.

Assuming the worst-case traffic scenario of a double-work shift, transporting all tailings pile material from the HMC-Grants Site to the off-site disposal location would require an estimated 150 daily truck trips (roundtrip) on vicinity roads. This would increase existing levels of all traffic on I-40 by approximately 1 percent (northbound and southbound). Using truck transportation under this alternative would almost double truck use of I-40 from the existing use; however, this increase would be distributed evenly over the 20 hours per day that work would be ongoing under a double-shift work schedule. The increased volume of traffic on local roads would be far more significant.

Trucks carrying borrow material would originate from undetermined borrow sources. All of these trips could occur on segments of I-40. An estimated 36 truckloads of borrow material would be transported daily.

Although there would be sustained increases in the AADT on I-40, project components could include a new access road to the off-site disposal cell location or the addition of acceleration and deceleration lanes that would alleviate safety concerns related to the use of existing roads by local, recreational, and commercial truck traffic. These construction requirements would be completed prior to the start of this project. It is assumed in Section 6.3.2.9 that a new roadway would be developed to transport tailings by truck, but that some existing routes would see an increase in traffic due to workers commuting, borrow material transport, and use of some existing roads for transport of tailings. This increase in traffic is likely to increase maintenance and repair needs of the existing roads.

3.16.2 Rail Transport

Rail transport would also require the transport of borrow materials as described above and would include 36 truckloads a day or 72 truck roundtrips. It could also require two to five truck trips per day to haul contaminated debris that could not be carried by rail. This additional truck traffic on I-40 could be noticeable. Quantities and costs associated with rail transportation are included in Table 6-7 and further described in Section 6.3.2.9.

Rail transport would require two daily train trips to carry tailings from the HMC-Grants Site to the off-site disposal cell location, which would occur seven days a week. Two trains per day would travel past intersecting county or state roads, which would result in vehicle delays of two to three minutes at the various railroad crossings. There would be potential safety concerns related to motorists waiting at these intersections.

The Burlington Northern and Santa Fe Railroad is approximately 4 miles southwest of Grants; a new railroad spur would have to be constructed to join this line at a minimum. A separate study would have to be conducted to survey the land, the preferred route, and the construction activities required to build this spur. However, the construction would result in a significant, short-term increase in construction traffic until the spur is completed and again for the removal of the spur (if required). For the purposes of costing, it was assumed that 30 miles of rail would need to be constructed, which may be necessary if existing track cannot accommodate the tailings transport or if the relocation site is not accessible by existing track.

3.16.3 Construction of Slurry Pipeline

A slurry pipeline would require limited transport of materials by truck. Transport of oversized materials that could not be transported by pipeline could result in additional use of trucks on I-40 (about six trucks per day). In addition, borrow materials would be transported as described under the truck transportation option. The short-term impact that would be associated with the 250 pipeline construction workers under the pipeline option would impact local traffic for the duration of pipeline construction. Quantities and costs associated with slurry transportation are described in Section 6.3.2.9 and tabulated in Table 6-8.

3.17 Socioeconomics

This section discusses potential socioeconomic impacts in the Grants area from the off-site disposal alternative. The aggregate impacts would depend on the mode of transportation used: truck, rail, or slurry pipeline. These impacts are examined using the Moab UMTRA project as a basis for information since an in-depth evaluation of the socioeconomic impacts of an off-site disposal alternative would depend on parameters such as off-site disposal cell location, length of project, and specific project needs. Potential impacts include an increased demand for temporary housing, and the short-term and long-term influence on the regional tax base and future economic development opportunities, and negative impacts including increased traffic, potential increase in crime, decreases in air quality, and greater demands on public resources.

The principal affected socioeconomic region of influence would be Cibola and McKinley Counties in western New Mexico. The industries expected to be initially affected include the regional construction and transportation industries, along with supporting service industries (especially hotels and restaurants). The project workforce is assumed to come from outside the socioeconomic region of influence and to spend a portion of their earnings on housing, food, and other goods and services within the principal two-county socioeconomic region of influence.

The increase in the workforce would also increase both traffic and traffic noise on local roads, and could cause an increase demand for local public services. Increases in population, even temporary, may also cause an increase in crime.

Environmental justice considerations must also be addressed. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (59 FR 7629), directs federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations.

The Council on Environmental Quality has issued guidance (CEQ, 1997) to federal agencies to assist them with their NEPA procedures so that environmental justice concerns are effectively identified and addressed. In this guidance, the Council encouraged federal agencies to supplement the guidance with their own specific procedures tailored to particular programs or activities of an agency. DOE has prepared guidance, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements, Second Edition* (DOE, 2004), based on Executive Order 12898 and the Council on Environmental Quality environmental justice guidance.

Among other things, the DOE guidance states that even for actions that are at the low end of the scale with respect to the significance of environmental impacts, some consideration (which could be qualitative) is needed to show that environmental justice concerns have been considered. It would be necessary to demonstrate that apparent pathways or uses of resources that are unique to a minority or low-income community have been considered before determining that, even in light of these special pathways or practices, there are no disproportionately high and adverse impacts on the minority or low-income population. The DOE guidance also defines "minority population" as a populace where either (1) the minority population of the affected area exceeds 50 percent or (2) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population.

These considerations are also applicable to Native American Reservations. There are three Reservations within the vicinity of the HMC-Grants Site, and two areas occur along the I-40 corridor to the east of the Site. A cultural resource survey would need to be conducted on any potential off-site disposal cell alternative location to determine if Native American-owned lands are within the vicinity, and any impact to the land owned by the Native American Nations would require evaluation. Reservations are not public land and are governed by Tribal Councils and other entities.

3.18 Human Health

3.18.1 Natural Radiation Environment

Radiation has been part of the earth's environment since its formation. Humans, animals, and plants are continuously exposed to ionizing radiation in the normal course of activities. Ubiquitous natural background radiation exposure consists of four main categories (NCRP, 2009):

- external exposure from radiation from space including solar particles and cosmic rays;
- external exposure from naturally occurring radionuclides on the earth surface (potassium-40 as well as the uranium-238, uranium-235, and thorium-232 decay series);
- internal exposure from radionuclides inhaled such as radon-222 and radon-220 and their decay products as well as radionuclides in dust re-suspended from the earth's surface; and
- internal exposure from radionuclides taken into the body in food and water.

The amount of ionizing radiation dose to the body is expressed in rem or mrem. The potential for health effects on the body is a function of the total dose. The average radiation dose to members of the public from ubiquitous background radiation in the United States is 310 mrem per year (NCRP, 2009).

The background radiation dose varies significantly depending on location. For example, while the average U.S. background radiation dose from cosmic radiation is 34 mrem per year, people who live at higher altitudes receive doses that range up to approximately 100 mrem per year. The average cosmic radiation dose to residents of Milan, New Mexico, at an altitude 6,600 feet above sea level is approximately the same as Colorado Springs, Colorado at 82 mrem per year outdoors (NCRP, 2009).

The external radiation dose from naturally occurring radionuclides on the earth's surface also varies with location depending on the composition of the soil and rock. The average annual dose to members of the public in the U.S. is 26 mrem per year. The estimated dose in central New Mexico is approximately 39 mrem per year based on a map of terrestrial dose rates in NCRP Report 160 (NCRP, 2009).

The average annual dose from radionuclides in the body is not dependent on location but is primarily a function of the concentration of potassium which, in turn, is dependent on muscle mass. The average annual dose to an adult male is 29 mrem per year, primarily from potassium-40 (NCRP, 2009).

Inhalation of radon decay products is the primary source of background radiation dose to members of the public, constituting 68 percent of the total dose (NCRP, 2009). The estimated average annual dose is approximately 210 mrem per year. The dose is highly variable and depends on location and lifestyle so it cannot be accurately predicted for any one individual or discrete population. The EPA considers Cibola County, New Mexico to be "Zone 2," that is, to have average screening radon concentrations between 2 pCi per liter and 4 pCi per liter, the EPA guideline for indoor radon. The national average radon concentration in homes is approximately 1 pCi per liter.

The total estimated average natural background radiation dose to members of the public in the Grants, New Mexico area is approximately 550 to 750 mrem per year compared to the national average of 310 mrem per year, primarily attributable to indoor radon exposure. Natural background radiation levels in other states in the southwest are similar to those in New Mexico.

The primary health concern with exposure to low levels of radiation is the potential for an increased risk of cancer. The International Commission on Radiological Protection (ICRP) has recommended risk coefficients, that is, numerical values for risk per unit dose, based on epidemiologic studies of individuals exposed to high levels of radiation, principally the atomic bomb survivors in Hiroshima and Nagasaki. Because cancer is a common disease, it is not possible to separate out the risk at low levels from the normal risk of cancer. Therefore, there is no direct evidence to show that exposure to low levels of radiation, in the range of background, result in an increased risk of cancer.

For the purpose of estimating the risks at low dose levels, the ICRP has developed what are termed "detriment-adjusted" cancer risk coefficients. That is, the risk coefficient takes into account fatal and non-fatal cancers. The ICRP detriment is based on fatal cancer risk weighted for non-fatal cancer, relative life lost for fatal cancers and life impairment for non-fatal cancers. The estimated risk for members of the general public is 5.5×10^{-7} (55 in 100,000,000) per mrem and 4.1×10^{-7} (41 in 100,000,000) per mrem for adult workers (ICRP, 2007). The estimated lifetime risk of cancer without radiation exposure (other than background) is approximately 0.45 for males and 0.38 for females, with a risks of fatal cancer equal to 0.23 and 0.20 respectively based on data from the National Cancer Institute (NCI, 2011).

3.18.2 Current Dose to Public

As noted in Section 3.18.1, radiation is a normal part of the earth's environment. The estimated annual natural background radiation dose to members of the public in Cibola County is 550 to 750 mrem per year. The potential annual dose to a member of the public attributable to the HMC-Grants Site is calculated annually and reported in the Semi-Annual Environmental Monitoring Report for the second half of each year. The highest estimated total effective dose equivalent (TEDE) to a hypothetical individual residing at the perimeter monitoring station with the highest measured air particulate, radon, and direct gamma radiation for 2011 was 71 mrem at HMC-4 (HMC, 2012). The estimated TEDE at HMC-5 was 66 mrem in 2011. The estimated 2011 TEDE at HMC-4 includes 0.2 mrem from inhalation of radionuclides in airborne particulates, 59 mrem from inhalation of radon decay products, and 11.6 mrem from direct exposure to radiation. The estimated 2011 TEDE at HMC-5 includes 0.7 mrem from inhalation of radionuclides in airborne particulate matter, 54 mrem from inhalation of radon decay products, and 11.6 mrem from direct gamma radiation. The HMC-4 and HMC-5 monitoring stations, located at the southwestern boundary of the site, are representative of the nearest residents. The nearest resident is located within 100 yards of the HMC-4 and HMC-5 monitoring stations. The groundwater/drinking water pathway was not included in the public dose as nearby residents are provided with city-supplied potable water.

3.18.3 Existing Occupational Risks

The existing occupational risks include the risk from radiation exposure and accident risks associated with normal working conditions. Radiation doses to workers at the HMC-Grants Site are monitored routinely with a dose report provided annually to the individual workers. The worker doses are reviewed and summarized in the HMC-Grants Annual ALARA Audit Report (HMC, 2012). The maximum external radiation dose to a worker in 2010 was 42 mrem. Doses from inhalation of particulates were not calculated for 2010 or first half 2011 since all measured values were below the 5 percent of the Derived Air Concentration (DAC), the concentration to which a worker could be exposed full time for a year. The ALARA Audit report noted that radon gas concentrations in the RO building were between 3.1 and 4.4 pCi/L for the first three quarters of 2011 but that the radon decay product concentration was low. Since occupancy of that building was only a few hours per week, no radon decay product dose was calculated for the workers. The maximum allowable dose to a worker under NRC regulations (10 CFR 20) is 5,000 mrem per year, excluding background radiation and doses from medical procedures. Doses are maintained As Low As Reasonably Achievable (ALARA).

Projected non-radiological risks to workers at the HMC-Grants Site (accidental fatalities) from a tailings relocation would be no different from risks in similar industries. The Bureau of Labor Statistics published fatal accident rates by type of industry. In 2010, the annual fatal accident rates per 100,000 full-time equivalent workers for mining, construction, professional and business services and all workers combined were 19.8, 9.5, 2.5 and 3.5 respectively (DOL, 2011). Because of the type of work that would be performed at the HMC-Grants site and off-site disposal cell location to construct and maintain buildings and structures associated with relocation of tailings, the risks would be expected to be consistent with the construction risks for general site workers and professional services for office workers. There are no specific data applicable to a tailings relocation project. Effective safety programs in place at the HMC-Grants Site would be expected to reduce those accident risks.

3.18.4 Risks Due to Transporting Tailings

The risks due to transportation of tailings, cover materials, and impacted soils from the Large Tailings Pile to a new disposal cell, including the estimated risks from construction of a slurry or rail line, were calculated using the risk estimates developed for the Moab UMTRA project in the FEIS (DOE, 2005). The general assumptions used in assessing the potential risks for transportation of the tailings from the Large Tailings Pile are given in Table 3-8. The dose rate estimates from the Moab FEIS were adjusted to account for the difference in average tailings concentrations for Moab compared to the average calculated tailings concentrations for the HMC-Grants Site, 516 pCi/g Ra-226 for Moab vs. 530 pCi/g Ra-226 for the HMC-Grants Site. Note that the HMC-Grants Site value is calculated, not measured, and would require measurement for more exact calculations.

Table 3-8. Transportation Risk Evaluation Assumptions

Parameter	Parameter Value	Source of the Information
Total mass of tailings in large tailings pile, impacted underlayment and cover material	22,000,000 tons (20,000,000 tons of tailings pile 10% increase for cover and underlying soils)	HMC-Grants Site Large Tailings Pile
Truck capacity	40 tons	Moab FEIS assumption of 44 tons decreased by 10% to be conservative
Distance between HMC-Grants and hypothetical new disposal cell	30 miles	Assumption
Total number of truckloads required	550,000	Mass divided by truck capacity
Total number of truck miles	3.3×10^7 (5.3×10^7 km)	60 miles round trip times 550,000 truckloads
Duration of project	10 years	Assumption
Truckloads per year	55,000 loads	Truckloads divided by duration of project
Days per year of operation	365 days	Assumption
Truckloads per day	150 loads	Truckloads per year divided by days per year
Fleet size	40 trucks	Assumption

Parameter	Parameter Value	Source of the Information
No. trips per day per driver	4 trips	Assumption
No. of days per year for each driver	240 days/year	Normal work year
Railcar capacity	100 tons	Moab FEIS assumption
No. of cars per trainload	30 cars	Moab FEIS assumption
Number of trainloads per day	2	Required to complete project in 10 years
Dose rate for truck driver	0.24 mrem/hr	Moab FEIS adjusted for HMC-Grants calculated tailings activity concentration
Dose rate for rail car inspector	0.48 mrem/hr	Moab FEIS adjusted for HMC-Grants calculated tailings activity concentration.
NM Truck accident rate (all types of roads combined 1994-96)	1.1×10^{-7} accidents/km	Saricks, 1999
NM Truck accident injury rate (all types of roads combined 1994-96)	1.1×10^{-7} accidents/km	Saricks, 1999
NM Truck accident fatality rate (all types of roads combined 1994-96)	1.1×10^{-8} accidents/km	Saricks, 1999
NM Rail freight accident rate	1.1×10^{-8} accidents/car-km	Saricks, 1999
NM Rail freight injury rate	1.1×10^{-8} accidents/car-km	Saricks, 1999
NM Rail freight fatality rate	7.0×10^{-9} accidents/car-km	Saricks, 1999
Slurry pipeline construction risk of fatality	2.32×10^{-4} per person year	Moab FEIS
Truck respirable release fraction (adjusted by probability of occurrence)	4.25×10^{-6}/accident	Moab FEIS
Rail respirable release fraction (adjusted by probability of occurrence)	1.1×10^{-5}/accident	Moab FEIS

Moab FEIS (DOE 2005)

3.18.4.1 Risk Due to Accidents

The risk of an accident for the duration of the project involving truck transport of tailings an assumed distance of 30 miles from the HMC-Grants Site to a new disposal cell was calculated using the risk factors in Table 3-8 and the total number of miles traveled over the 10 year estimated project duration. The total number of truck miles is 33,000,000 or 53,000,000 km. The estimated total number of accidents, injuries, and fatalities over the life of the project are 5.8, 5.8, and 0.58 respectively.

The risk of an accident for rail transport for the duration of the project was calculated by multiplying the total number of rail cars required over the 10-year period to move 22,000,000 tons of tailings, cover materials, and impacted soils by the risk factors in Table 3-8. Assuming a rail car capacity of 100 tons, the total number of rail cars required would be 220,000, moving over an assumed distance of 96 km (round trip) for a total of 2.1×10^7 car-km. The calculated total number of accidents, injuries, and fatalities over the duration of the project are 0.23, 0.23, and 0.15 respectively.

In the absence of specific data, the risk associated with construction of the rail line was assumed to be the same as the risk used in the Moab FEIS for slurry pipeline construction, since the Moab FEIS did not include risks from construction of a rail line. The Moab FEIS assumed 225 worker-years for construction of a slurry line from Moab to Klondike Flats, a rail distance of approximately 16 miles. The number of worker days for the rail line construction was assumed to be approximately the same for the purposes of this estimate. Therefore, the same number of worker-years was used in the calculation. Using a risk factor of 2.32×10^{-4} per worker-year, the risk of fatality is 5.2×10^{-2}. If the construction of rail line takes longer or involves a greater distance, this risk is likely to increase.

The risk of injury or fatal accident from transport of the tailings by slurry line was considered negligible since the tailings would be contained. However, the estimated risk of a fatality during construction is 5.2×10^{-2}.

The estimated potential risks of accidents attributable to transportation of tailings from the HMC-Grants site to an off-site disposal cell location at a distance of 30 miles are summarized in Table 3-9. These numbers do not reflect individual risks but rather the total risk of injury or fatality. The transportation risks are assumed to include risks to workers as well as members of the public from accidents.

Table 3-9. Estimated Potential Accident Risks from Transportation of Tailings

	Truck	**Rail**	**Slurry Pipeline (construction of slurry pipeline accounted for in construction risks)**
Total Accident Risk	5.8	0.23	
Risk of Injury	5.8	0.23	
Risk of Fatality	0.58	0.15	(0.05)

3.18.4.2 Radiation Dose and Risk

The potential annual external radiation dose to a truck driver was calculated assuming the driver was actually in the truck for eight hours per day, 240 days per year. The estimated direct radiation dose rate based on the Moab FEIS (DOE, 2005) and adjusted for the average Ra-226 concentration in the HMC-Grants Site Large Tailings Pile is 0.24 mrem per hour for a total annual dose of 480 mrem per year. The collective annual dose, assuming 60 truck drivers making 4 round trips each day for 240 days per year would be 29 person-rem per year. The annual individual risk, based on the ICRP risk coefficients, would be 1×10^{-2}. Assuming a 10-year project duration, the estimated collective dose would be 288 person-rem. The detriment-adjusted risk of one additional cancer to the truck driving work force attributable to direct radiation during the project would be 0.1.

The estimated external radiation dose to a rail worker inspecting shipments for two hours per day would be approximately 1 mrem per day or 240 mrem per year. Assuming that there are a minimum of three inspectors working full time, the collective dose would be 0.72 person-rem per year. The lifetime detriment-adjusted cancer risk to an individual from one year of exposure would be 1×10^{-4}. The collective dose for the duration of the project would be 7.2 person-rem for an estimated potential number of cancers of 0.003.

The potential dose to a truck driver or a rail worker from inhalation of radionuclides in airborne particulate matter released during an accident was estimated by assuming the probability of an accident with release of the tailings would be 0.20. The total number of accidents predicted to occur during truck transport, based on New Mexico statistics, is 5.8. If 20 percent of those accidents results in release of the tailings, the number of accidents resulting in a release is approximately 1.2.

The concentration of radionuclides in the air the worker breathes would depend on whether the individual was inside or outside the vehicle and the atmospheric conditions during the accident. Assuming that the transportation worker is outside the vehicle and is breathing a dusty atmosphere (no respiratory protection) at the OSHA nuisance dust Permissible Exposure Limit, 15 mg per cubic meter, for a period of one hour at a breathing rate of 1.7 cubic meters per hour, the intake of tailings would be 0.026 grams. The dose per gram of tailings inhaled, 59 mrem, is given in Table 3-13 in Section 3.18.6. The total dose from inhalation of particulates due to a release from an accident would be approximately 1.5 mrem per hour of exposure. The dose to workers, assuming that it would take two eight-hour days to clean up the spilled tailings, would be approximately 26 mrem. Radon would be dissipated rapidly, before significant radon decay products could build up, therefore the dose would be minimal. The estimated direct radiation dose to the cleanup worker would be approximately the same as for a truck driver or 0.24 mrem per hour for a total of 3.8 mrem for the task. The total estimated radiation dose would be 28 mrem. The collective detriment-adjusted cancer risk, assuming four cleanup workers would be 5 x 10^{-5}.

3.18.5 Construction and Operations Impacts and Risks associated with Tailings Relocation

The human health impacts associated with construction of the off-site disposal cell, excavation of the tailings from the HMC-Grants Site, and placement in the off-site disposal cell can be expected from both accidents and radiation exposure. The primary potential risk is from accidents during operations. However there is a potential for direct gamma radiation from the exposed tailings and inhalation of airborne particulate material and radon decay products during excavation and placement of the tailings. The potential impacts of transportation are covered in the Section 3.18.4 above.

The tailings in the HMC-Grants Site Large Tailings Pile are currently covered; therefore, the direct radiation and particulate inhalation pathways do not contribute to the dose as long as the cover is not disturbed. Radon doses to current workers are monitored and described in the annual ALARA Audit reports, and are minimal. The calculated impacts in this section apply to the excavation of tailings and placement in an off-site disposal cell.

The potential for construction accidents resulting in a fatality were calculated using fatality rates for various work categories from the Moab FEIS (DOE, 2005) shown in Table 3-10. The total numbers of workers in each category are hypothetical estimates and would vary depending on the specific Work Plan associated with implementation of the off-site disposal alternative, including the expected duration and the potential for using more than one shift per day. The number of workers required was increased by approximately 50 percent over the work force required for the Moab Site and the duration of the off-site disposal alternative (10 years) was assumed to be longer than was originally proposed for the Moab UMTRA project. The total mass of tailings at the HMC-Grants Site Large Tailing Pile is greater than the tailings and associated materials at the Moab Site.

Table 3-10. Construction Risks Due to Excavation of Tailings from the HMC-Grants Large Tailings Pile Impoundment

Work Category	Fatality Rate per person-year (DOE, 2005)	Estimated Project duration (years)	Hypothetical No. of workers	Person-years	Projected Fatalities (or probability of a single work-related fatality)
Equipment operator	2.16×10^{-4}	10	38	380	0.082
Site support	7.47×10^{-5}	10	25	250	0.019
General Labor	3.29×10^{-4}	10	30	300	0.099
On-site Truck Driver (off-site risk included in transportation accident analysis)	3.88×10^{-4}	5	3	15	0.006
Rail track maintenance during cell and railroad line construction (rail option only)	7.62×10^{-4}	10	1	10	0.008
Rail or pipeline (slurry option) construction	2.32×10^{-4}	1	250 (estimate based on Moab Crescent Junction Option)	250	0.058
Total projected fatalities for truck option					0.206
Total projected fatalities for slurry and rail options					0.272

The risks from construction of an off-site disposal cell and placement of tailings are essentially similar to the risks from excavation of the tailings at the HMC-Grants Site (Table 3-11).

Table 3-11. Risks from Construction of the New Cell and Emplacement of Tailings

Work Category	Fatality Rate per person-year (DOE, 2005)	Estimated Project duration (years)	Hypothetical No. of workers	Person-years	Projected Fatalities (or probability of a single work-related fatality)
Equipment operator	2.16×10^{-4}	10	38	380	0.082
Site support	7.47×10^{-5}	10	25	250	0.019
General Labor	3.29×10^{-4}	10	30	300	0.099
Total projected fatalities					0.200

The total projected risk of fatality from excavation of tailings, construction, and placement of tailings in an off-site disposal cell and transportation risks are summarized in Table 3-12.

Table 3-12. Summary of Fatal Accident Risks from Relocation of Tailings

	Truck Option	Rail Option	Slurry Line Option
Excavation of Existing Tailings	0.206	0.272	0.272
Construction and Placement in Off-Site Disposal Cell	0.200	0.200	0.200
Construction of a final cap over the tailings	Unknown	Unknown	Unknown
Transportation	0.58	0.15	
Total Accident fatality risk	0.99	0.62	0.47

These estimated risks are applicable only to the excavation, transportation and placement of tailings and do not include installation of a final cover. These risks also do not include accidents and fatalities that are associated with transport of borrow material. For the purpose of comparison of options, it is assumed that the risk would be the same for capping in place and constructing a cap over the new disposal facility.

3.18.6 Potential Radiation Doses from Excavation and Placement of Tailings

The potential radiation dose to workers from moving tailings from the HMC-Grants Site Large Tailings Pile to an off-site disposal cell location would result from increased direct radiation exposure from uncovered tailings and inhalation of particulates and radon decay products.

The potential radiation dose to workers constructing the off-site disposal cell would be no different from background as the excavation is assumed to be in an uncontaminated area. However, as noted in the section below, excavation and placement of the tailings would result in radiation doses to workers, exposing to workers to risks that are not presented by the covered tailings if left undisturbed.

3.18.6.1 Direct Radiation Exposure

The average radionuclide concentrations of tailings in the HMC-Grants Site Large Tailings Pile were calculated based on the total mass of tailings and the reported total production of yellowcake during the life of the mill. The total amount of the tailings and associated material in the HMC-Grants Large Tailings Pile is 22,000,000 tons (4.4×10^{10} lbs). The total reported yellowcake production over the life of the mill was 83,000,000 pounds. Therefore, the estimated ore grade was 0.19 percent. The uranium concentration in yellowcake is 85 percent. The average uranium concentration in the ore is assumed to have been 0.16 percent. The activity concentration for U-238 is 3.3×10^5 picocuries per gram (pCi/g). Ore with a uranium mass concentration of 0.16 percent would have a U-238 activity concentration of 530 pCi/g. Assuming the efficiency for the mill process was 95 percent and all of the decay products of Th-230 are in equilibrium, the concentrations of the uranium decay series would be as shown in Table 3-13. Uranium-235 and its decay products are assumed to be present at an activity concentration of 0.045 times the concentration of U-238, consistent with the natural abundance of 0.72 percent.

Table 3-13. Assumed Average Radionuclide Concentrations in HMC-Grants Tailings and Dose Coefficients

Nuclide	Activity Concentration (pCi/g)	Inhalation Dose Coefficient from ICRP, 1999 (mrem/pCi)	Dose per gram of tailings inhaled (mrem/g)
U-238	27	0.0296	0.784
U-234	27	0.0348	0.940
Th-230	530	0.0519	27.507
Ra-226	530	0.0352	18.656
Pb-210	530	0.0207	10.971
U-235	1	0.0315	0.032
Pa-231	1	0.1259	0.126
Ac-227	1	0.2667	0.267
Total dose per gram of tailings inhaled			59.3

The direct radiation dose from uranium and its decay products was calculated assuming a dose rate of 1.25 x 10^{-3} mrem per hour per pCi/g (mrem-g/pCi-hr) for the U-238 decay series (UNSCEAR, 2000). Nearly all of the direct radiation dose from the U-238 decay series comes from the decay products, not the uranium itself. Therefore, the dose coefficient for the U-238 decay series is applicable even though most of the uranium has been removed from the tailings. The dose rate at the surface of an infinite plane of tailings at a concentration of 530 pCi/g would be 0.66 mrem/hr.

Assuming a worker spends 2,000 hours per year on the uncovered tailings in a vehicle or heavy equipment with a shielding factor of 0.5, the annual dose would be 660 mrem from direct radiation. The total number of equipment operators is projected to be 38. The total annual collective dose would then be 25 rem or 250 rem for the duration of the project. The estimated risk of cancer using the ICRP 103 cancer detriment risk coefficient for workers of 4.1 x 10^{-4} per rem (4.1 x 10^{-7} per mrem) would be 0.1. The estimated risk could be significantly lower if the pile were to remain partially covered during tailings excavation.

3.18.6.2 Potential Dose Due to Inhalation of Radionuclides

The potential dose from inhalation of radionuclides in airborne particulate matter was calculated assuming an average dust concentration during excavation equal to 10 percent of the OSHA nuisance dust permissible exposure limit (PEL) or 1.5 mg/m^3. Dust suppression techniques such as adequate watering would reduce that concentration by a factor of two. The calculation assumes no dust suppression but incorporates a shielding factor of 0.5 for the cab of a vehicle or heavy equipment. Assuming a breathing rate of 1.2 m^3/hr and a work year of 2,000 hours, the estimated annual intake of airborne particles would be 1,800 mg or 1.8 g. Using the dose coefficient in Table 3-13, the annual effective dose would be approximately 106 mrem. The collective dose for 38 workers would be 4.1 rem per year. Assuming a duration of 10 years, the total collective detriment-adjusted cancer risk would be 0.017.

The potential dose to workers at the tailings pile from inhalation of radon decay products released during disturbance of the tailings would not be significant since the radon would be dissipated outdoors before the decay products could build in.

The potential doses to other site workers would be attributable primarily to inhalation of radon decay products. Radon gas will be released from the tailings when they are excavated. Radon itself is not a significant health hazard as it is a noble gas and is exhaled with little or no deposition in the body. However, radon decay products are deposited in the lung. Radon decays to its short-lived alpha emitting decay products over time. The concentration of the decay products in air is a function of the time since release of the gas. At approximately four hours, the decay products are fully in equilibrium with the radon gas. The fraction of equilibrium indoors is generally approximately 0.5. Concentrations of radon decay products in air are expressed in terms of Working Level (WL). One WL is equal to 100 pCi/L of radon in air in equilibrium with its decay products. At 50 percent of equilibrium, a concentration of 1.0 pCi/L of radon would be equivalent to a radon decay product concentration of 0.005 WL.

Radon decay product exposure is expressed in Working Level Months (WLM). One WLM is equivalent to exposure to a radon decay product concentration of 1.0 WL for 170 hours (a normal working month). Therefore, the exposure in WLM is equal to the concentration in WL times the number of hours of exposure divided by 170 hours per month.

The annual radon emission rate attributable to excavation of tailings is estimated to be 420 Ci/yr. Assuming an average site worker is indoors at a distance of 500 feet downwind from the excavation, the annual frequency of wind in that direction is 10 percent, the average wind speed is 7.3 meters per second (m/s), and relatively stable atmospheric conditions (stability class D), the concentration due to excavation would be as follows:

$C = Q/(\pi \sigma_y \sigma_z u)$ where: Q = source term = 420 Ci/yr = 13 μCi/s

σ_y = horizontal dispersion coefficient at 500 feet = 12 m (Shleien, 1998)

σ_z = vertical dispersion coefficient at 500 feet = 6.7 m (Shleien, 1998)

u = average wind speed = 7.3 m/s

C = 13 μCi/s/(3.14*7.3 m/s*12 m*6.7 m) = 7.1 x 10-3 μCi/m^3 = 7.1 pCi/L

Assuming the wind blows in the direction of the worker 10 percent of the time, the average annual incremental concentration attributable to tailings excavation would be 0.71 pCi/L. If the worker spends most of his or her time indoors, the radon decay product concentration at an equilibrium factor of 0.5 would be 0.0035 WL. The annual exposure would be 0.04 WLM. The estimated effective dose per WLM exposure is 1.0 rem (NCRP, 2009). The estimated dose from 0.04 WLM is 0.04 rem. The estimated lifetime risk per year of exposure would be 2 x 10^{-5}. Assuming a total work force other than construction crews of 20 individuals, the collective risk per year of exposure would be 4 x 10^{-4}, or 4 x 10^{-3} for the duration of the project.

The potential dose and risk to workers placing the tailings in the off-site disposal cell would be approximately equal to the dose and risk to workers from excavation, again assuming the tailings are stockpiled then moved into position in the cell.

3.18.7 Radiation Risks to Public from Relocation of the Tailings

The total risk to members of the public from off-site disposal of the tailings would include the risks due to excavation and removal of tailings at their current location at the HMC-Grants Site and the risk due to placement of the tailings in an off-site tailings disposal cell. The risks include inhalation of radon decay products as well as inhalation of airborne particulates emitted by the construction activities.

The average concentration of Ra-226 in the tailings assumed for the purpose of calculating potential doses and risks to members of the public is 530 pCi per gram based on the total mass of the tailings and the number of pounds of uranium produced at the mill. The efficiency of the mill process was assumed to be 95 percent, leaving 5 percent of the uranium in the tailings. The assumed concentrations of the long-lived uranium decay series radionuclides of concern are given in Table 3-13.

The estimated radon concentration at the nearest residence a distance of 0.5 miles (0.8 km) from the tailings piles was calculated in the same manner as for the on-site worker. The vertical dispersion coefficient (σ_z) for stability class D at a distance of 0.8 km is 27 m; the horizontal dispersion coefficient (σ_y) is 50 m. The calculated incremental radon concentration at the nearest residence due to excavation of the Large Tailings Pile is 0.04 pCi/L. Assuming 75 percent occupancy and an indoor equilibrium factor of 0.5, the annual exposure in WLM would be 0.008. The radon decay product dose would be 8 mrem per year. The total dose over a 10 year period would be 80 mrem for an individual risk of 4×10^{-5} for a residence a distance of 0.5 miles from the Large Tailings Pile.

According to the Agency for Toxic Substances and Disease Registry (ATSDR) Health Consultation Report, approximately 200 people live within a mile of the tailings piles (ATSDR, 2008). Assuming all of these individuals live at a distance of 0.5 miles from the piles, the collective dose over the 10 year duration of the project would be 16.0 person-rem and the collective incremental cancer risk would be 9×10^{-3}.

The potential doses to members of the public from inhalation of radionuclides in particulate matter generated during excavation of the Large Tailings Pile would be significantly less since most of the particulate matter would settle out before reaching the local residences. However, the concentration at a distance of 0.5 miles can be calculated in the same manner as the radon concentration using the same dispersion coefficients and the estimated annual average particulate emissions from the excavation of the Large Tailings Pile. The estimated total annual particulate emissions from excavation of the tailings, assuming they are moved twice, is 1.0×10^6 lbs for the 10 year duration of the project or a emission rate of 1.4 grams per second (g/s). Using the same dispersion coefficients as for the radon calculation and assuming 10 percent of the time downwind, the estimated annual average particulate concentration at the nearest residence, attributable to excavation of tailings, would be 4.6×10^{-6} g/m^3. Assuming an individual inhales 16.3 m^3/d for 365 days per year (EPA, 2011b), the total annual inhalation intake of tailings dust would be 0.027 g/year. The estimated dose would be 1.6 mrem. The collective dose over a 10 year period would be 3.2 person-rem. The collective cancer risk would be 0.002 from inhalation of particulates, for a total of 0.01 for the duration of the project.

The potential collective doses to members of the public from placement of the tailings in an off-site disposal cell would depend on the location chosen for the facility. See Table 3-14 for estimated annual radiation doses.

Table 3-14. Estimated Annual Radiation Dose (mrem/yr)

Location	Direct Gamma	Radon Decay Products	Dust Inhalation	Total	Dose Limit	Estimated Collective Risk for the Duration of the Project (1)
Tailings excavation and placement worker	660	NA	106	766	5,000	1×10^{-1}
General site worker	NA*	40	NA	40	5,000	4×10^{-3}
Truck driver	460	NA	NA	460	5,000	1×10^{-1}

Location	Direct Gamma	Radon Decay Products	Dust Inhalation	Total	Dose Limit	Estimated Collective Risk for the Duration of the Project [(1)]
Rail car inspector	250	NA	NA	240	5,000	3×10^{-3}
Spill clean-up worker**	3.8	NA	26	30	5,000	5×10^{-5}
Public in the vicinity of the tailings excavation	NA	8	1.6	9.6	100	1×10^{-2}

[(1)] Risk is calculated using the ICRP detriment-adjusted cancer risk factors. The ICRP detriment was based on fatal cancer risk weighted for non-fatal cancer, relative life lost for fatal cancers and life impairment for non-fatal cancers.

*Not applicable
**Collective risk is probability of occurrence x risk; assumes four workers

3.18.8 Monitoring and Maintenance Impacts

The impacts to human health from monitoring and maintenance prior to license termination and Long Term Maintenance by the DOE are limited to potential radiation doses to monitoring personnel in proximity to the off-site disposal cell and the risk of travel from the HMC-Grants Site to the off-site disposal cell location on a weekly basis for filter exchange. The incremental radiation dose and risk would be negligible due to the short period of time required to conduct the monitoring.

The risk due to vehicle accidents was calculated using the statistics from the National Highway Traffic Safety Administration (NHTSA) for 2010 (DOT, 2012). The fatality and injury rates for 2010 were 1.10 per 100 million vehicle miles traveled and 75 per 100 million vehicle miles traveled, respectively. Assuming a distance of 30 miles each way between the HMC-Grants Site and the off-site disposal cell location and a total of 52 trips per year, the annual vehicle miles traveled for monitoring and maintenance would be 3,120. The annual risk of fatality and injury would be 3.4×10^{-5} and 2.3×10^{-3} respectively. Monitoring will continue post completion of the project; therefore, no duration was assumed for monitoring impacts.

3.19 Considerations Associated with Borrow Areas

Based on plans from Moab, borrow materials that would need to be obtained from off-site locations to reclaim the site surface areas after removal of the Large Tailings Pile and to create a cap for the off-site disposal cell include: cover (moisture storage) soils, radon/infiltration barrier soils, capillary break in the form of sand and gravel, and riprap. These materials would likely be excavated and trucked to both sites. They would be stockpiled in an uncontaminated staging area then used for cover construction and surface reclamation. Hauling and excavation operations would be governed by the standard operating procedures of the quarry. Some riprap is already stockpiled at the HMC-Grants Site for use in final cover and decommissioning of the site and it could be used as needed for implementation of an off-site disposal alternative. However, more material would be needed for the off-site disposal alternative, and transport would require additional personnel and equipment. For costing purposes, it was assumed that all cover materials would need to be commercially obtained and transported to the HMC-Grants Site and the off-site disposal cell location.

The Large Tailings Pile was originally constructed at ground level without excavation. Over time, the weight of the pile has likely caused some subsidence, and water drainage through the pile has likely impacted soils at least 2 feet deep across the bottom of the pile. The footprint of the Large Tailings Pile would need to be leveled and the soil cover would need to be used to meet the radon-222 release limit of no more than 20 Ci/m^2 per second, when averaged over the entire surface of the footprint and over at least a one-year period, for the control period of 200 to 1,000 years (NRC, 2002). In addition, the cover would have to meet the radium-226 subsurface standard of 15 pCi/g above background averaged over a 100 square meter (1,076 square foot area) (40 CFR 192.12). It is assumed that all cover material would need to be commercially obtained and trucked to the HMC-Grants Site.

The off-site disposal cell would need to capped at the end of tailings transport, and would require the same materials and specifications as the final cover for the footprint. Using material estimates from Moab, increased 25 percent to account for the larger amount of tailings from the Large Tailings Pile approximately 2,245,188 cubic yards of material would be needed. It is also assumed that all materials would need to be trucked to the off-site disposal cell location.

Similar procedures and costs would be associated with excavation and transport of borrow materials, regardless of the borrow area selected. Excavation would require bulldozers to scrape and stockpile soil. Front-end loaders would be needed to load trucks from the stockpile and tandem trucks would be needed to transport the materials.

In general, it is likely that access roads would need to be constructed or upgraded to the borrow areas to accommodate the amount of traffic that would be generated by the large needs of the off-site disposal cell alternative. Based on estimates from the Moab effort, it would take approximately 10 days to build a five mile stretch of access road and would require delivery of road base materials, which could extend the length of time needed to construct an access road. It may also be necessary to have a temporary office at the borrow area, with portable toilets. Water trucks for dust suppression would also be needed. Again, the specific needs could only be determined after identifying borrow area sites.

Disturbance related to the borrow area would potentially be extensive, and topsoil from the borrow area would need to be stockpiled and replaced in order to reclaim the borrow area. At the end of excavation, the top soil would be replaced and replanted with native vegetation.

Excavation and transport of borrow materials could be continuous over the course of approximately seven years, perhaps longer depending on the needs of the off-site disposal cell facility, transport distance for the borrow materials, or shorter workshifts than assumed in the estimates (Table 3-18). Consistent with the Moab site, it is assumed that a fleet of approximately 28 trucks could be used. Soils would be stockpiled at the HMC-Grants site and the off-site disposal cell location in an uncontaminated area and used as needed to backfill and cover when the relocation is complete.

Potential borrow areas are not specified here as such borrow material locations would be identified based on the location of the off-site disposal cell. However, material requirements can be estimated without specifying borrow area locations and are shown in Table 3-18. Costs have been estimated in Section 6.3, but will vary depending on the distance that the materials would need to be transported as well as the price of the materials themselves. The following subsections describe the standards needed for the borrow materials specified.

3.19.1 Riprap

Riprap is an outer layer of stone that protects the cover soils (water storage soils), capillary break sand and gravel, and the radon barrier soil from erosion due to wind, precipitation, or flooding. The riprap would need to meet durability standards specified in NUREG-1653, Design of Erosion Protection for Long-term Stabilization (NRC, 2002). The riprap durability requirements are determined by the long-term design requirements, which are based on the expected erosive forces at the off-site disposal cell location. Potential riprap borrow areas would need to be tested to determine if they meet the long-term design requirements of both the off-site disposal cell location and the Large Tailings Pile footprint area. The existing Large Tailings Pile is armored with riprap that meets or exceeds these standards.

3.19.2 Cover Soils

Cover soils have the primary function of minimizing infiltration of water to the underlying materials. The cover soils absorption characteristics are to be such that water is retained in the soils when the cover vegetation is dormant. During the growing season, vegetation in the overlying soil/rock moisture of riprap layers would extract the stored water, thereby minimizing any downward permeation of water. Three soil textures that provide the best storage capabilities are loams, silt loams, and clay loams (texture definitions as provided by the U.S. Department of Agriculture). The borrow locations would need to have soils that meet the waterholding and rooting criteria necessary for the off-site disposal cell location and Large Tailings Pile footprint.

3.19.3 Sand and Gravel

Again, the primary function of coarse sand and gravel layer (capillary break layer) is to minimize downward movement of water under saturated conditions. The coarse sand and gravel layer would be placed under the cover soil layer and above the radon barrier soils, increasing the water storage capacity of the upper layers. Other sand and gravel would be mixed with soil to form the top layer of the footprint cover, which would provide erosion control. The sand and gravel materials would need to meet the same materials durability standards as listed in NUREG-1623 (NRC 2002) for riprap.

3.19.4 Radon and Infiltration Barrier

The radon barrier is a compacted layer of clay that would be placed directly above the bottom of the footprint at the location of the relocated LTP, and on top of the tailings at the disposal cell. The thickness of the radon barrier would be based on calculations of radon flux from the tailings, calculated to determine the compacted soil layer thickness that would prevent the annual average radon flux from exceeding 20 pCi per square meter per second. For purposes of this report, a thickness of 12 inches was assumed for the tailings pile footprint, but it is likely that more would be needed. The amount of radon barrier material that would be needed for the disposal cell is based on material estimates for Moab, increased 25 percent for the larger volume of tailings.

3.19.5 Transport Truck Traffic Density

Based on estimates created for Moab and increased to account for a 25 percent larger pile at the HMC-Grants Site, backfill material transport could be on-going for approximately five years to the HMC-Grants Site and up to eight years for the off-site disposal cell location.

The on-site footprint figures are based on 2 feet of cover soil, 12 inches of radon barrier soil, and 6 inches each of sand and gravel and riprap. Additional materials would require additional trips and time. Six inches of riprap may not be sufficient to meet NRC durability standards; also, it is possible that the more than 2 feet of excavation would be needed. The amount of truck traffic to the HMC-Grants Site would be 36 additional trips each day, 365 days per year. For the disposal cell, transport of materials could take 7.5 years; again, 36 truck trips per day to the site would be expected, 365 days per year. The estimates for the off-site disposal cell are uncertain because the location would dictate the number of trips, and design of the off-site disposal cell may impact the amount of materials needed. Table 3-15 provides a summary logistics for hypothetical borrow area material transportation.

Table 3-15. Summary Logistics for Hypothetical Borrow Area Material Transportation

Borrow Material	Daily Round-Trips (1-year backfill operation) (a)	Total Volume (yd^3)	Total Shipments	Years (b)
On-Site Footprint				
Cover soils	19	638,880 (2 feet deep)	19,360	2.8
Radon/infiltration barrier soils	9	322,667 (12 inches deep)	9,778	3.0
Sand and gravel	3	161,334 (6 inches deep)	4,889	4.5
Riprap	5	161,334 (6 inches deep)	4,889	2.7
TOTAL	36	1,284,213	34,607	
Off-site Disposal Cell				
Cover Soils	9	1,553,750	47,083	6.8
Radon/infiltration barrier soils	9	367,500	11,136	3.4
Sand and gravel	3	269,688	8,172	7.5
Riprap	5	54,250	1,644	0.9
TOTAL	36	2,245,188	68,036	

(a) Daily roundtrips are based on Moab estimates for on-site transportation of borrow materials, 33 cubic yards of material per shipment, and double work shift.
(b) Assuming 365 days/year of transport.

3.20 Off-Site Disposal Cell Failure from Natural Phenomenon

Even with the most thorough planning, unforeseen natural phenomena could occur to breach the integrity of the off-site disposal cell. Such failure could include a leak in the liner, erosion of the cover, flooding that removes the cover and moves tailings, wildfire, tornado damage, mudslide, or earthquake. The extent of environmental and human health impacts from such a failure could range from minor to substantial depending on the type of failure, population or environment impacted, size of the impact, and the amount of time needed to provide a remedy.

4.0 UNAVOIDABLE IMPACTS, SHORT-TERM USES AND LONG-TERM PRODUCTIVITY, AND IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

As part of the decision-making process, an environmental impact statement is needed as part of the evaluation of alternatives. An EIS would require both a study and in-depth discussion of the environmental impacts of the proposed actions and a discussion of alternatives, and information on any adverse environmental impacts that are unavoidable, impacts on short-term uses and long-term productivity of the environment, and any irretrievable or irreversible commitment of resources. The following sections provide a brief description of each of these considerations, with the realization that specific impacts and their magnitude could only be identified if an off-site disposal cell location were to be selected.

The resource estimates provided below for the on-site alternative are based on project information from HMC. For the off-site disposal cell alternative, estimates of the use of natural resource uses are based on calculations from the Final Environmental Impact Statement for Moab, July 2005, corrected for the greater amount of material at the HMC-Grants Site Large Tailings Pile and foreseeable issues that are relevant to HMC-Grants Site.

4.1 Unavoidable Adverse Impacts

Under the current on-site alternative, EPA has determined that the risks to the public are low (EPA, 2006) and ATSDR has determined that no public health risk exists (ATSDR, 2009). EPA has an additional risk assessment that will be published in 2012, but preliminary results relayed on March 8, 2012 (EPA, 2012a), show that off-site radon exposure is not attributable to the HMC-Grants Site.

Under the off-site disposal cell alternative, there would be an increase in radiation doses to the public and workers as a result of excavation, preparation, transportation, and disposal activities. The activities and excavation of the Large Tailings Pile at the HMC-Grants Site would increase wind dispersion of particulates and radon, as the radon barrier would be breached and tailings would be placed in drying pads prior to shipment. In addition, transportation of the tailings involves risk and the potential for accidental release, which could result in an increase in excess cancer risk as it increases the potential for exposure to both the public and workers, as well as providing additional pathways for tailings to enter the environment.

For activities related to tailings excavation and transport, RESRAD or MILDOS modeling would be needed to estimate the increased total risk of a latent cancer fatality for the maximally exposed member of the public. At Moab, the highest increased total risk of a latent cancer fatality for the maximally exposed member of the public for the duration of the excavation and relocation activities was estimated at 8.8×10^{-3}. In addition, radon exposures at the off-site disposal sites were estimated to result in a latent cancer fatality risk to the maximally exposed member of the public of between 2.0×10^{-5} and 1.0×10^{-4}. A more exact estimate for the excavation, transport, and disposal of the tailings from the Large Tailings Pile cannot be calculated unless an off-site disposal cell location site is selected. Some of the concerns with the Moab tailings project may not apply; nonetheless, the risk is appreciable. Excavation, transport and disposal of the Large Tailings Pile at an off-site location is estimated to present an overall excess risk of cancer to workers of 1×10^{-1} (1 in 10), and to residents near the HMC-Grants Large Tailings Pile of 1×10^{-2} (1 in 100).

Under the off-site disposal alternative, there would be an unavoidable increase in truck and other construction-related traffic and traffic due to commuting workers. This unavoidable adverse impact would occur seven days per week for 10 years, and would primarily but not exclusively impact New Mexico Hwy 605 and I-40. If activity occurred only five days per week, the traffic increase would last 14 years. Both assumptions do not allow for holidays or delays due to inclement weather or equipment maintenance, which would extend the length of the off-site disposal alternative.

Off-site transportation of tailings by truck would result in the greatest increase in traffic. The highest local traffic impacts would occur if tailings were trucked on a route including I-40 or through the towns of Grants and Milan due to the increase in local traffic. Under this disposal transportation mode, there would be an unavoidable impact of an additional 36 round-trip truckloads of borrow material seven days per week for up to six years to the Site; 150 truckloads of tailings off of the HMC-Grants Site per day for 10 years; and a large increase in personal vehicle traffic for workers coming to the HMC-Grants Site.

Additional traffic and noise associated with the off-site disposal alternative would result in displacement and increased mortality of wildlife close to construction areas and transportation routes. Additionally, under the off-site disposal alternative, projected annual withdrawals of alluvial, Chinle, and perhaps San Andres Aquifer water would likely exceed currently permitted limits set by NMED. The Moab project estimated maximum annual water requirements ranging from 235 to 730 acre-feet that would continue for five to 10 years, depending on work schedules and transportation modes. Given the 25 percent larger volume of tailings at the HMC-Grants Site, these estimates would be 294 to 913 acre-feet annually and would have to be supplied through groundwater sources. Slurry pipeline transportation of the tailings would require the greatest volume of water; however, water use for the off-site disposal alternative (including any of the three transport scenarios) would likely exceed the current permitted withdrawal limits for the Site. The water would not be returned to the aquifers from which it is drawn.

Further, the creation of a rail line or use of access corridors for a slurry pipeline would remove some land from further development along the transportation route until the project is complete and the lines removed. Further, it could complicate road or utility repair along the length of the transportation corridor.

Unavoidable adverse impacts to cultural resources and traditional cultural properties would likely occur under the off-site disposal alternative. Many cultural resources and traditional cultural properties are located in the vicinity of Grants. The density, variety, and complexity of cultural resources that could be unavoidably and adversely affected is quite large in this area and, under the off-site alternative, mitigation would be extremely difficult. Lower densities of known resources occurs along the I-40 corridor, however, these areas contain more dense populations, privately held lands, and higher potential for negative visual impacts. Relocation siting would need to evaluate the cultural resources and traditional cultural properties that could be impacted, but such impacts would be nearly unavoidable within 30 miles of the Site.

Implementation of the off-site disposal alternative would create a conflict between the local short-term uses of the environment and long-term productivity. Land required for the off-site disposal cell would be unavailable for other uses in perpetuity. This conflict could be significant given the proximity of national forest, traditional and cultural lands, privately held lands, and grazing areas.

Under the on-site alternative, the entire 1,000 acres of tailings pile, evaporation ponds and infrastructure would be unavailable for other uses in perpetuity. DOE would have responsibility for monitoring the site after closure is complete. Under the off-site disposal alternative, both the HMC-Grants Site and the off-site disposal cell location would require post-closure monitoring, the extent of which would be project specific and determined by regulatory agencies; however, post-closure the monitoring would still be the responsibility of DOE. Moreover, under both alternatives, the groundwater treatment at the HMC-Grants Site would continue until restoration goals have been met

Under the off-site disposal alternative, relocation of the 20 million tons of tailings plus impacted cover soils and excavated underlayment (estimated total amount of 22 million tons) could require over 1,000 acres of land to be permanently unavailable at the off-site disposal cell location. The Moab UMTRA project disposal site has 500 acres of dedicated land (DOE, 2008). At least 1,000 acres of land would be needed for HMC-Grants tailings, assuming a depth of 20 feet of tailings at the disposal site, and additional acreage would be needed around the perimeter of the cell as a buffer zone.

4.2 Irreversible or Irretrievable Commitment of Resources

The irreversible or irretrievable commitment of resources that would occur if the off-site disposal alternative was implemented is the use of:

1) Fossil fuels in the transport of tailings and borrow materials
2) Borrow materials
3) Steel, and/or petroleum product materials, if the slurry pipeline transport were implemented
4) Steel to create a rail line, if rail transportation is used
5) Asphalt or other pavement for roads
6) All construction materials
7) Land for the disposal cell in perpetuity

All alternatives would require an irretrievable commitment of millions of gallons of gasoline and diesel fuel.

The estimated total fuel consumption for the current on-site alternative is up to $23,000 per year (approximately 7,600 gallons). Based on estimates from the Moab effort, which were increased 25 percent to account for the larger volume of tailings at the HMC-Grants Site, the estimated total fuel consumption for the off-site disposal alternative would range from 33.9 to 60.9 million gallons for truck transportation, from 27.4 to 45.7 million gallons for rail transportation, and approximately 22.5 million gallons for slurry pipeline transportation assuming a 10-year span of transportation. Implementation of any of the alternatives would also require the use of borrow materials to cap the tailings pile and for site reclamation. These materials would include cover soils, radon/infiltration barrier soils, sand and gravel, and riprap and could involve more fuel use depending on the collection and transport distance for the borrow materials.

It is estimated that the total volume of irretrievably committed cover soil borrow material would be approximately 3.5 million cubic yards for filling the Large Tailings Pile footprint left after excavation, capping the footprint, and capping the off-site disposal cell. Using these estimates, the maximum area of land that would be disturbed to extract cover soil borrow materials would be approximately 729 acres for the off-site disposal alternative, assuming a 3-foot excavation depth at the borrow area. The final acreage of disturbed land would depend on the selection of borrow areas and depths to which borrow soils would be extracted.

Pipeline transport of tailings for off-site disposal would use about 7,887 tons of steel that may become sufficiently contaminated to require disposal in the cell. These estimates are based on the Moab pipeline design from the Moab site to the Klondike Flats sites (an 18.8 mile distance), adjusted for an assumed 30 mile distance. The slurry pipeline design used here assumes that the steel would comprise the outer wall of the double-walled system and, therefore, it may not become contaminated. However, for the purposes of this estimate, it was assumed that the steel would require disposal in the new cell.

Under the off-site disposal alternative, there would be an irreversible and irretrievable commitment of the additional land that would be needed for the off-site disposal cell, approximately 1,000 acres. The HMC-Grants Site containing the current Large Tailings Pile and associated evaporation ponds and infrastructure are currently committed to their irretrievable use and this would not change even if the off-site disposal alternative were to be implemented.

The off-site disposal alternative would result in the irretrievable commitment of alluvial, Chinle or San Andres aquifer water, which may exceed the usage limits currently permitted. Additionally, water would be required at the off-site disposal cell location, which would have to be supplied by groundwater, surface water, or public water supply. Much of the use would be irretrievable because the water would be used for dust suppression, on-site or off-site decontamination, other construction-related uses, or possibly slurry production and ultimately would evaporate in double-lined evaporation ponds or be encapsulated in the off-site disposal cell. The estimated maximum annual consumption of water estimated for Moab was 130 to 235 acre-feet for the rail transportation option, 135 to 240 acre-feet for truck transportation, and 730 acre-feet for slurry pipeline transportation (DOE, 2005). Based on the larger volume of tailings at the HMC-Grants Site, annual water demand would be closer to 163 to 294 acre-feet the rail transport, 169 to 300 acre-feet for truck transport and 913 acre-feet for slurry pipeline transport. This water would be drawn from the alluvial, Chinle or San Andres aquifers as no surface water body in the area can supply this need. The source of water for the off-site disposal alternative would depend on the exact location of the off-site disposal cell and options for water. These annual figures are middle-range estimates for irretrievable commitments of water, as water would be needed for dust suppression activities as well as decontamination of equipment at both the HMC-Grants Site and the off-site disposal cell location.

5.0 REGULATORY REQUIREMENTS

The following subsections provide a list of regulations that may apply or would be considered in implementing the off-site disposal alternative. The list is not meant to be comprehensive, as other statutes and regulations may be applicable depending on the off-site disposal cell location, transport route, and affected communities.

In addition to the regulations listed below, public meetings and community involvement in the Superfund process are required by law, with assistance and funding provided for community organizations through Technical Assistance Grants (TAG) and Technical Assistance for Superfund Communities (TASC) programs. Public and community meetings would be a necessary part of any relocation alternative.

5.1 Federal

- Endangered Species Act (ESA) (16 U.S.C. 1531–1534)
- Clean Water Act: 33 U.S.C. 1251 et seq., 40 CFR 330 Appendix A (Sections 401 and 404)
- Rivers and Harbors Act (Section 10)
- Resource Conservation and Recovery Act: 42 U.S.C. 6901 et seq., 40 CFR 262 subparts A–D
- Wilderness Management Act (16 U.S.C. 1131)
- Wildlife and Fisheries (50 CFR 36.39)
- CERCLA (42 U.S.C. 9620, 40 CFR 300)
- Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA)
- NUREG 1620 – Standard Review Plan
- Atomic Energy Act of 1954
- Disturbing a Marked Burial Ground
- Antiquities Act of 1906
- National Register of Historic Places (36 CFR Part 60)
- Preservation of American Antiquities (43 CFR Part 3)
- Protection of Archeological Resources (43 CFR Part 7)
- Protection of Historic Properties (36 CFR Part 800)
- National Environmental Policy Act of 1969
- National Historic Preservation Act of 1966 (16 U.S.C. 470, 36 CFR 63, 36 CFR 800)

5.2 State

Standards for interstate and intrastate surface waters, State of New Mexico Standards 20.6.4.109 NMAC, 2011:

- Air Quality, *New Mexico Administrative Code:* Title 20, Chapter 2
- Radiation Protection, *New Mexico Administrative Code:* Title 20, Chapter 3

- Hazardous Waste, *New Mexico Administrative Code:* Title 20, Chapter 4
- Petroleum Storage Tanks, *New Mexico Administrative Code:* Title 20, Chapter 5
- Water Quality, *New Mexico Administrative Code:* Title 20, Chapter 6
- Solid Waste, *New Mexico Administrative Code:* Title 20, Chapter 9
- Licensing Requirements for Land Disposal of Radioactive Waste, *New Mexico Administrative Code:* Title 20, Chapter 3, Part 13
- New Mexico Cultural Properties Protection Act of 1969
- New Mexico Prehistoric and Historic Sites Preservation Act of 1993
- New Mexico Cultural Properties Preservation Easement Act
- New Mexico Historic Districts and Landmark Act of 1965

5.3 County

Regulations for the counties of McKinley and Cibola would need to be followed, as well as those of any other county through which transport occurs or in which the off-site disposal cell were to be located.

5.4 Native American Cultural Protection and Reservations

- American Indian Religious Freedom Act of 1978
- Archeological Resources Protection Act of 1979 (16 USC 470aa-mm)
- Historic Sites Act of 1935
- Native American Graves Protection and Repatriation Act of 1990 (43 CFR Part 10)

6.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES AND ENVIRONMENTAL CONSEQUENCES

The following subsections summarize potential impacts from the on-site and off-site alternatives, including estimated costs. Table 6-1 summarizes impacts, Table 6-2 presents estimated greenhouse gas emissions, and Table 6-2 presents total estimated costs for each alternative.

6.1 Impacts affecting HMC-Grants Site and Vicinity, Transportation Corridors, and Off-Site Disposal Locations

6.1.1 On-Site Alternative

The on-site alternative for final site closure is currently underway. Groundwater remediation has been ongoing for many years and is scheduled for completion in the near future. At such time, the Large Tailings Pile will be capped in place, and radioactive material and demolished buildings will be capped in one of the existing lined evaporation ponds. The tailings pile flushing program will be finished and monitoring of the groundwater will continue under the supervision and direction of DOE.

The issues surrounding the closure of the Large Tailings Pile in place is a community concern of continued or new impacts to groundwater, the visual impact of the Large Tailings Pile to surrounding residents, and concern regarding potential health impacts from radon release after closure. The EPA is conducting a human health risk assessment to address concerns regarding radon release, but sampling results presented to date have not shown a link between in-home radon measurements and the Large Tailings Pile (EPA, 2012a). There will be noise and vibration impacts associated with final covering of the Large Tailings Pile and activities associated with final closure and decommissioning of the HMC-Grants Site, but these impacts are expected to be short term (less than two years).

Groundwater remediation and reclamation will continue even if the off-site disposal alternative were to be implemented. Groundwater remediation has been successful, but it is unlikely that the shallow aquifers in the immediate vicinity of the HMC-Grants Site will be useable for unrestricted domestic use as the background concentrations of some constituents are above levels typically considered acceptable to the State. Homes in the vicinity have been connected to municipal water supplies for domestic use, and the groundwater at these residences can be used for irrigation or livestock watering. The ATSDR investigated risks associated with groundwater use and found no apparent public health hazard as wells being used as a source of potable water did not contain contaminants at levels that would produce known health effects (ATSDR, 2009).

The Large Tailings Pile, at 100 feet high and covering approximately 200 acres, is noticeable from Highway 605 and from many of the nearby neighborhoods. However, it has been in place for many decades, and final cover design may lessen the visual impact. The HMC-Grants Site will not be available for any other use into perpetuity and will not be open to the public.

6.1.2 Off-Site Alternative

Impacts from the off-site disposal alternative are far more extensive and associated with much more uncertainty than the on-site alternative.

Under the off-site alternative, the creation of a new disposal cell large enough to accommodate the tailings would require an extensive amount of land that will be irretrievably committed for perpetuity as a disposal cell. The removal of that land as habitat has the potential to adversely affect native wildlife that may be present, including elk, deer, antelope, Mexican spotted owl (threatened species), and native vegetation (including the Pecos sunflower, a threatened species) that have critical habitat in the vicinity of Grants. Additional evaluation would need to be conducted to determine whether any of the threatened species occur within the location selected for the off-site disposal cell. Evaluation of potential impacts to these species would require coordination with the U.S. Fish and Wildlife Service and New Mexico Department of Game and Fish. If potential impacts are projected, then measures would need to be taken to avoid or minimize impacts to the extent possible, and to mitigate for unavoidable impacts. Potential impacts to an endangered or threatened species on federal land could require preparation of a Biological Assessment (BA) for review by USFWS, and impacts to a species on private lands could require development of a Habitat Conservation Plan (HCP).

There are significant amounts of pronghorn, mule deer, and elk habitat in the area, including a portion of the Cibola National Forest. Potential environmental impacts on federal land would trigger compliance with the National Environmental Policy Act (NEPA), which would likely require preparation of either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). Other state and federal lands include El Malpais National Conservation Area (managed by Bureau of Land Management), El Malpais National Monument (managed by the National Park Service), the West Malpais and Cebolla Wilderness Areas (BLM-managed as part of El Malpais National Conservation Area), and the Bluewater State Park (managed by New Mexico State Parks Division).

Once the location of the off-site disposal cell was identified, transportation routes and methods must be approved by the U.S. and New Mexico Departments of Transportation and conform to all regulations regarding transport of hazardous material. The amount of truck traffic that would be generated by truck transportation of tailings is large and would have noticeable visual and noise impacts, a negative impact on air quality, and the potential for accidents and accidental releases. Rail transport may not have as much of an impact on traffic, but under any scenario additional workers would be needed at the HMC-Grants Site and the off-site disposal cell location, which will increase personal vehicle traffic with adverse impacts from vehicle emissions. In addition, trucking of borrow material to both the HMC-Grants Site and the off-site disposal cell location would increase traffic, the potential for traffic accidents, and have adverse impacts to air quality and noise.

Monitoring of the off-site disposal cell location site would be required, from preconstruction to establish baseline conditions, through construction of the disposal cell and placement of tailings, to closure and long-term monitoring. Soil, vegetation, water, and air must be monitored, and if surface water bodies are present near the off-site disposal cell location, food, fish, surface water, and sediment samples must also be collected and monitored (NRC, 1980). Personnel must also be monitored for radiation exposure. All disposal cells will have the potential for leaks to develop or for releases to occur due to natural phenomena and leak detection monitoring will be necessary.

Construction of the off-site disposal cell and related infrastructure development at both the HMC-Grants Site and the off-site disposal cell location would likely take up to three years to finalize and become operational, after all permitting and approvals are received. Construction of a rail line could take longer, depending on the distance. Construction will have negative noise and vibration impacts, which could be disruptive to residents and wildlife.

The off-site disposal alternative will involve a much greater use of consumable materials and fuel than the on-site alternative. This is an irretrievable commitment of resources and will produce greenhouse gas emissions.

The potential risk to human health is significant under the off-site disposal alternative. It is estimated, based on transport assumptions and accidents rates, that a worker fatality can be expected. Based on estimated exposure to radioactive material, the increased cancer risk to nearby residents would be approximately 1 in 100. Increased cancer risk to workers involved in tailings pile excavation and placement at the off-site disposal cell location is estimated at 1 in 10. All risk assumptions include conservative estimates that do not account for catastrophic releases or exposures.

Given the large number of cultural resources in the area and lands belonging to Native American tribes, environmental justice issues would need to be examined prior to implementation of the off-site disposal alternative. There are many culturally important lands in the vicinity of Grants, and many are located near transportation routes or are adjacent to national forest.

Table 6-1. Potential Impacts of On-Site and Off-Site Alternatives

Category	On-Site Alternative	Off-site Alternative
Geology and Soils	No seismic potential	Seismic potential unknown
	Subsidence has been monitored and is not a factor at this time	Unknown, but minimized by design
	Site is not a source of geological resources and land is already permanently unavailable	Geological resources at disposal site would become permanently unavailable; mineral rights of land holder would be terminated
	Borrow materials will be needed for permanent cover of large tailings pile	Borrow materials would be needed for cap of new disposal cell; borrow materials would still be needed for the HMC-Grants Site Large Tailings Pile footprint and cap. Estimates of material needed would be close to 3.5 million cubic yards
	No added potential for soil erosion	Excavation and construction for emplacement and removal of slurry pipeline would disturb topsoil and result in increase in potential for soil erosion along a pipe line corridor for the 30 mile hypothetical distance. Soil erosion could occur as footprint is backfilled.
Air Quality	Current air quality monitoring indicates no significant release of radon or particulates.	PM-10 emissions would require dust control measures; particulate emissions and radon emissions will increase

Category	On-Site Alternative	Off-site Alternative
Groundwater	Groundwater impacts at the Site are well documented and currently being remediated.	Groundwater at the off-site disposal cell location could be impacted if a liner failed or other accidental release occurred. Groundwater would require monitoring. Groundwater impacts at the HMC-Grants Site would still be remediated even if the off-site disposal alternative were to be implemented, so there is no cost savings.
	Groundwater extraction would continue at current rate for groundwater remediation	Additional groundwater would be needed for the off-site disposal alternative.
Surface Water	No on-site surface water is present	Surface water bodies could be present at the off-site disposal cell location or along the transportation corridor that could receive accidental release of materials. Surface water bodies at the off-site disposal cell location could receive wind-dispersed particulates.
Floodplains and Wetlands	Site is not in a floodplain and no wetlands are located in the vicinity	Potential to impact wetlands would need to be evaluated for any site selected as the off-site disposal cell location. Areas within a floodplain would not be acceptable.
Aquatic Ecology	No potential impacts to aquatic ecology from on-site alternative.	Aquatic ecology impacts are possible, depending on the off-site disposal cell location and transport route.
Terrestrial Ecology	No additional impacts are expected from on-site alternative. Area is not available for habitat at this time.	Habitat destruction is unavoidable.
Land Use	Land area of HMC-Grants Site will not be developed and is dedicated to groundwater reclamation until permanent closure.	Any land taken for the off-site disposal cell will be permanently unavailable for any other purposes (estimated area of 1000 acres).
Cultural resources	Location of the HMC-Grants Site is not in a cultural resource area.	Cultural resources and Native American lands occur within the vicinity of Grants and could be impacted by implementation of the off-site disposal alternative. At a minimum, the potential impacts of the off-site disposal alternative would need to be evaluated.

Category	On-Site Alternative	Off-site Alternative
Noise and Vibration	Until closure of facility, no noise or vibration is expected. When tailings piles and ponds are closed in place, noise and vibration from building demolition and movement of cover materials is expected. Duration of impacts is not expected to exceed 2 years.	Noise and vibration from excavation and transport of tailings is expected year-round for a minimum of 10 years, plus construction noise and vibration for at least 2 years prior to tailings move. Additional noise and vibration would be expected during backfill and closure of Large Tailings Pile footprint, expected to take at least 1 year. In addition, building demolition and evaporation pond closure would still occur as planned and would result in additional noise and vibration for 2 years prior to construction start. At the off-site disposal cell location, construction noise will occur while building the disposal cell and associated infrastructure (at least 2 years). Noise and vibration associated with relocation of the tailings would occur for a minimum of ten years. Additional noise and vibration from transport and placement of cover material would occur for up to 8 years.
Visual Resources	Tailings pile is visible from road and nearby residences, and would remain visible after closure. Reclamation design could minimize visual impact. Pile has been at current location for over 50 years.	Off-site disposal cell will disturb any area that is selected as a relocation site. Over the estimated 10-year project, visual impacts would be moderate to severe. After closure, visual impacts could be moderated by design, but the land would not return to its native state.
Infrastructure, Construction, and Resource Requirements	Industrial water supply in place. All necessary infrastructure already in place. No additional construction or infrastructure is needed.	Infrastructure at HMC-Grants would need to be expanded to accommodate larger work force and extensive program needs. Drying areas and staging areas would need to be constructed. Depending on transportation mode selected, slurry pipeline, conveyor belts, rail car loading areas or rail would need to be constructed. Additional buildings would need to be constructed at the HMC-Grants Site. Off-site buildings will be required. Electricity and water supplies would need to be secured for the off-site disposal cell location. Sanitary and solid wastes would need to be disposed of. All terminal process buildings and structures would need to be constructed.
	Current water demands known and met; water for dust minimization will be needed for site demolition and decommissioning.	Water for dust minimization will be needed; needs will exceed those of the on-site alternative and will create a new demand for water at the off-site disposal cell location

Category	On-Site Alternative	Off-site Alternative
	Fuel will be needed for equipment used to provide demolition of buildings and final closure to Site.	Fuel needed for transport of tailings is estimated at up to 550,000 gallons per year for truck transport. Additional fuel would be consumed by transport of borrow materials, equipment used to construct and then cover the off-site disposal cell, and personal vehicles used by workers.
	No additional buildings are needed or will be built. Current buildings will be demolished on-site at final closure and capped in an existing evaporation pond.	Buildings will be needed for workforce at the off-site disposal cell location and HMC-Grants Site. Buildings/structures will be required at HMC-Grants and disposal cell for transport of tailings (type depends on transportation mode selected).
	Sanitary waste generation is not expected to significantly increase from current levels.	Generation of sanitary waste will increase at the HMC-Grants Site. Off-site disposal cell facilities for sanitary waste will need to be developed.
Waste management	Waste currently disposed of at municipal landfill. Slight increase in waste expected from closure of facility but would not overwhelm municipal landfill capacity.	Based on Moab estimates, an additional 1,040 cubic yards of solid waste would be generated and require disposal in a municipal landfill. Over 10 years, solid waste generated would total 10,400 cubic yards.
Socioeconomics	Slight increase in workers required for closure; temporary housing needs could be met locally or from nearby municipalities.	Increase in local spending would be expected to meet the demands of a larger workforce for the time period of construction and excavation, transport and placement of the tailings.
Human Health	Human health impacts are not expected to change from current levels, which have been noted as minimal by ATSDR and are being analyzed by EPA for off-site radon exposure.	Increase in exposure to radon, radioactive particulates, and direct gamma radiation will occur to workers and potentially to off-site receptors. The estimated risk to off-site residents near the HMC-Grants Site from excavation of the tailings pile is 1 in 100 of developing a cancer. There is an estimated 10% risk of cancer to tailings excavation and placement workers.
Traffic	Little increase in traffic is expected from on-site closure. Increase would be short-term (2 years).	Significant increases in traffic would be expected and would last for the duration of the project (minimum 10 years).
Environmental Justice	HMC-Grants is not a cultural heritage site.	Many cultural heritage sites are within the vicinity of the HMC-Grants Site. Transportation of tailings could cross through culturally important properties and the off-site disposal cell could adversely affect heritage sites.
Disposal Cell Failure	Site monitoring is in place and conditions have been monitored for many years. Any change in conditions would be quickly recognized. Site is not within a floodplain or area of seismic activity.	Unknown consequences; consequences would depend on location of off-site disposal cell and surrounding environment.
Transportation Accidents	Not applicable.	Estimates show likelihood of fatal accident and release of radioactive material to the environment.

6.2 Impacts Affecting Potential Borrow Areas

Borrow areas are not identified, as locations would be dependent of the location of the off-site disposal cell. However, regardless of where the borrow materials are secured, land disturbance of the borrow areas will be extensive. The amount of cover material needed (approximately 3.5 million cubic yards) would require 729 acres of land excavated 3 feet deep. While some material may come from excavations deeper than 3 feet, land disturbance and habitat destruction is an unavoidable consequence of collecting and moving this large amount of material. In addition, the movement of material may impact surface water drainage at the borrow areas and adversely impact surface water bodies and wildlife.

Various types of borrow materials would be needed for cover materials for the off-site disposal cell location and for fill material for excavated areas at the HMC-Grants Site. These materials range from silts and clays to riprap that would be used to armor the sides of the disposal cell. Borrow areas that would provide these materials would need to be identified for any area selected as a potential off-site disposal cell location. Distance from the borrow areas to the off-site disposal cell location and the HMC-Grants Site will affect the cost of material.

The proposed borrow areas would be evaluated for suitability by conducting site-specific investigations, such as digging test pits and drilling boreholes to determine conditions and obtain material samples for further evaluation. Borrow areas selected for evaluation would typically cover an area larger than would be used, which would allow a contractor enough area to adequately test and configure the borrow area for project needs. However, regardless of where the borrow materials are secured, land disturbance of the borrow areas will be extensive and irreversible. If the deposit of borrow material were not as deep as anticipated (3 feet), a larger surface area would be required. A larger area for borrow material also would allow the contractor greater flexibility to avoid any sensitive resources encountered.

The borrow material transport would include a large amount of truck traffic that could be disruptive to traffic patterns, the local community, and wildlife, as well as having an adverse impacts to air quality from fuel exhaust.

6.3 Costs

Table 6-2 tabulates the estimated costs of the on-site and off-site alternative evaluated in this report. The on-site estimated costs were developed by HMC and were accepted by the NRC in December 2011 (NRC, 2011). Estimated costs for the off-site disposal alternative are based on available site-specific information as well as the estimates developed for the Moab site (DOE, 2005). When the original Moab UMTRA project costs (DOE, 2005) were used here, they were tripled to account for real costs as experienced at Moab compared to their original estimate; increased 25 percent to account for the large volume of tailings at HMC-Grants; and adjusted for inflation (25 percent increase). In addition, costs associated with studies that would be needed to identify an off-site disposal cell location have been included, as well as an estimate of costs associated with acquiring the site, transportation corridor access, and the purchase of mineral or water rights if needed. These costs were not included in the Moab estimates as they were not applicable to that effort.

The total for the on-site alternative is $41.1 million with a projected end date of 2017. The total estimated cost for the off-site alternatives is from nearly $1.8 billion to over $2 billion, approximately 48 times the cost of the current remediation plan, with a projected end of date of the end of 2035. There is no foreseeable benefit to removing the tailings pile except that it would be placed in a lined disposal cell and perhaps be less visible. However, substantial risk and cost is associated with moving the large tailings pile. Groundwater remediation and monitoring of the current HMC-Grants Site would not terminate and the off-site disposal alternative could not begin until well after groundwater remediation is completed, as construction of supporting infrastructure and staging areas would disrupt the current groundwater well system. In addition, siting studies, environmental reports, public hearings, and pre-construction monitoring are estimated to take up to 7 years to complete prior to any construction under the off-site alternative. After 3 years of construction, tailings relocation would take at least 10 years under a very aggressive work schedule. After relocation is complete, reclamation and final closure of the HMC-Grants Site and the hypothetical disposal cell are estimated to take an additional two years. Assuming a hypothetical start date of 2013, no interruption to work for any reason, and a very aggressive relocation schedule, the off-site alternative would not be complete before the end of 2035.

More specific descriptions of cost for the off-site alternative are provided in Section 6.3. An estimated timeline is presented in Figure 6-1. The timeline assumes no project interruptions, including delays due to weather, supply chain shortages, or accidents, with all work conducted 365 days per year. Transport of tailings was assumed to take 10 years.

6.3.1 Current On-site Remediation and Site Closure

The remaining cost for on-site remediation is currently estimated at a total of $41.1 million (NRC, 2011). The continued on-site groundwater treatment is estimated to cost $12.5 million, at which time closure of the groundwater restoration program is anticipated. This cost is a committed expenditure as groundwater remediation must be complete prior to any other action (any site disturbance could disrupt the current groundwater treatment systems and monitoring network). On-site monitoring and regulatory costs are estimated at $1.8 million through the term of the groundwater remediation and closure of the site and includes general costs, air and weather monitoring, radiation monitoring, and settlement monitoring of the Large Tailings Pile.

On-site general, administrative, security and maintenance costs are estimated at $6.0 million through reclamation and Site closure. Facility reclamation, tailings pile closure, and decommissioning are estimated to cost $14.5 million and include RO plant demolition, demolition of other on-site buildings, closure of the evaporation ponds, and closure of the large and small tailings piles in place. A portion of this cost would not be expended if the off-site disposal alternative were to be implemented; however, for costing purposes, it was assumed that most costs would be incurred due to the intricacies involved in completion of the tailings pile flushing program and interim measures that would be taken to reduce radon emissions even if the off-site alternative were to be implemented. An adjustment of $1 million was used in the cost estimates to reflect that a final cap would not be placed on the Large Tailings Pile if the off-site alternative were to be implemented.

Additionally, a 15 percent contingency is included in the current remediation budget per NRC requirements, with approximately $817,000 in NRC long-term maintenance and surveillance fees.

6.3.2 Off-Site Alternative

The costs for the off-site alternative were estimated based on an assumed distance to the off-site disposal cell location of 30 miles, consistent with the Moab UMTRA project. This distance was chosen for the off-site alternative evaluation to allow more simple cost comparisons and to incorporate project budget increases as have been experienced at Moab. It is assumed that the off-site alternative evaluated here would face similar challenges as Moab, and Moab is currently the most comparable project in scope. In general, the Moab project has faced an increase in cost of approximately three times the original estimate of $472.3 presented in the 2005 FEIS (DOE, 2005). The current cost to complete estimate for the Moab UMTRA Project is $1.04 billion (DOE, 2009), which did not include an American Recovery and Reinvestment Act award of $108 million that was granted to the project. The 2005 FEIS and subsequent budgets also do not present a detailed description of preliminary cost expended prior to the FEIS and selection of remedy. Preliminary site identification costs are presented here and are based typical costs of large-scale environmental studies, engineering design, and remediation planning.

The off-site alternative could, conceivably, be accomplished by truck, rail or slurry. The truck scenario is the least expensive, at approximately $1.75 billion. The rail scenario is approximately $2.01 billion, and the slurry option is $2.13 billion. In all cases, the majority of the estimated cost is related to tailings handling, followed by construction costs. The three transportation scenarios share some common costs: siting studies, environmental impact studies, site characterization; site acquisition, field management, project management, cover material, erosion protection, and surveillance and maintenance of sites.

Each task presented in the estimated costs (Table 6-2) is described below. Note again that the costs involved in the current on-site remediation plan are included in the cost estimate of the off-site alternative as current on-site groundwater reclamation, closure, and decommissioning would have to be complete prior to implementation of the off-site disposal alternative. Tailings facility closure/reclamation costs from the on-site alternative were decreased by $1 million in the estimate of the off-site alternative, as the Large Tailings Pile would not be closed but closure of the evaporation ponds, RO plant, small tailings pile and all other structures would need to be completed even if the Large Tailings Pile were relocated.

6.3.2.1 Siting Studies/EIS

The Siting Studies/EIS estimate, presented in Table 6-3, includes costs associated with locating and evaluating potential off-site disposal cell locations. Prior to performing an engineering or environmental study of any sort, potential locations must be identified and a preliminary evaluation of suitability must be performed. This would necessarily include public meetings with all potential stakeholders for each location. For costing purposes, it was assumed that 10 locations would be initially identified and public input would be sought for each location. It was then assumed that five locations would be further evaluated. Each initiative would require planning, meetings, draft reports, administrative record keeping, and project management.

After potential locations are preliminarily identified, more detailed studies would need to be conducted at each location. The investigations would require more extensive information searches as well as site visits by personnel to provide a preliminary site characterization and identify issues potentially requiring further study. Abbreviated investigations of the physical site characteristics would be required at each location, requiring safety and health plans, sampling plans, and quality assurance plans. Preliminary soil, groundwater, and surface water samples would be collected and abbreviated ecological or biota studies conducted to ensure a potential location is acceptable and that there are no site constraints that would render it unacceptable as an off-site disposal cell location under any conditions.

Preliminary investigations of socioeconomic considerations would also be conducted, to ensure that the proposed off-site disposal cell location and activities do not have adverse impacts that disproportionately affect disadvantaged segments of the population. Again, public meetings, stakeholders meetings, and project management are included in this effort.

Cost of regulatory oversight is included in the estimate for siting studies. Superfund regulations require that the principally responsible party for a Superfund site reimburse the agency for costs related to oversight of remediation programs. The amount is determined by the scope of the project. An estimated annual cost of $450,000/year for five years of siting studies was used in the cost estimate, although this value would be based on the needs of regulatory oversight for the project, as determined by EPA and others in the regulatory framework. The value could vary greatly from the estimate used here.

Preliminary engineering designs are also included in the cost of the siting studies. A baseline cost was determined by an estimated hourly rate of $200/hour for six months of fulltime work 960 hours) for most tasks associated with the preliminary engineering design. For preliminary designs of each of the three transport scenarios, the number of hours needed was tripled (2,880 hours). Such designs would be necessary for the preparation of the EIS, based on the available reports from Moab UMTRA project.

The EIS is envisioned to include three iterations: a draft, draft final and final report. Stakeholder meetings as well as public commentary are a necessary part of creating the final document. Responses to comments can be lengthy given the number and scope of comments that may be received when public commentary is sought. Based on experiences at Moab, nearly three years passed from issuance of the intent to prepare an EIS and the publication of the FEIS in 2005. However, in the initial efforts to remediate the Moab site, the first environmental assessment was released in 1994 and the final EIS report was not issued until 1999 (DOE, 2010). For this report, it was assumed that the EIS process would take three years, although it may take longer. The total cost of producing a final EIS is nearly $2 million and includes administrative record costs that are associated with performing the EIS, such as publication of Notices of Intent in the Federal Register.

Finally, other regulatory costs associated with reports, negotiations, meetings, and permits with entities other than EPA are estimated at an annual cost of $850,000. This includes all salaries and direct and indirect costs that could be incurred to meet the concerns of all regulatory agencies. This cost captures, for example, meetings with state and local regulatory agencies such as the New Mexico OSE and NMED, state and federal departments of transportation, the Department of Energy, and the NRC. Movement of radioactive material is subject to many regulations and the particular project needs can be more complex than those involving non-radioactive materials.

6.3.2.2 Site Characterization

Characterization of the off-site disposal cell location is included as a separate budget item. The estimated cost of $7.5 million is based on the 2005 Moab UMTRA project FEIS estimate for site characterization of $1.6 million (in 2003 dollars). The 2003 value was tripled, to account for the tripling of costs noted in the subsequent Moab budget estimates, then adjusted for inflation to 2012 dollars (U.S. Bureau of Labor Statistics, 2012), and increased again by 25 percent to account for the increased volume of material at the HMC-Grants site as compared to Moab. The increased volume of tailings will likely require a more extensive area for a disposal cell, resulting in additional land that must be characterized.

Site characterization could require an estimate of human health impacts within a 50-mile (80 km) radius, using a modeling program such as MILDOS or RESRAD. Such modeling is generally required at sites creating a tailings pile at a new or active mining site, and concerns would be similar at the creation of an off-site disposal cell. Uncovered tailings will release both dust particulates and radon. Depending on the transportation mode used, tailing may need to be dried before placement into trucks or rail cars. If open-air drying beds are used, emission will be higher. Cost of performing modeling programs for radioactive particulate emissions, radon, and any other modeling programs for other environmental media are included in the site characterization cost. The modeling would be needed at both the HMC-Grants Site ("origin location") and the off-site disposal cell location ("terminal location").

The total cost of siting studies, EIS, and site characterization presented here total $19.5 million dollars. As a comparison, the Baseline Summary for Moab UMTRA Project (DOE, 2009) noted that costs associated with that project from 2003 to 2006 (pre-construction efforts) totaled $38.2 million. Table 6-4 presents the site characterization cost estimate, which is likely to be an underestimate.

6.3.2.3 Environmental, Health and Safety, and NEPA Costs

Environmental, health and safety, and NEPA costs are different for each mode of transportation. In each case, though, the costs reflect tasks associated with air monitoring, groundwater monitoring, surface water monitoring, weather monitoring, radiological monitoring, biota monitoring, and worker monitoring. Annual updates of plans are required as well, including health and safety plans, emergency incident response plans, health physics plans, and radiation protection program policy. Periodic reports generated under this task could include annual environmental reports, quarterly and annual surface water monitoring reports, quarterly and annual groundwater monitoring reports, biota impact reports, quarterly and annual air monitoring reports, waste management reports, and storm water/site runoff management reports. In addition, annual or periodic reports may be required by the Occupational Safety and Health Administration (OSHA) regarding safety reporting.

The reports generated would need to consider impacts along the transportation route as well as at the origin (Large Tailings Pile) and the terminal location (off-site disposal cell). For this reason, the slurry pipeline option is associated with lower costs because no emissions or releases would be expected during transport and fewer employees would be involved in tailings transport. Costs associated with continued public meetings and notifications, including maintaining a public document library and information website, are included in this task. The costs are presented in Table 6-4.

For the truck transportation scenario, the estimated cost for this task is $78.8 million; for rail, it is estimated at $80.2 million and for the slurry option, $45.5 million. While these numbers are based on costs from the Moab project (accounting for budget increases, inflation, and increased volume of tailings associated with the Large Tailings Pile), the annual costs of each, based on 20 years for the complete project (five years of preconstruction/construction, 10 years of transport, and five years of closure), are

> Truck: $3.94 million ($1.33 million each for HMC-site, off-site disposal cell, and transport route)
>
> Rail: $4.01 million ($1.34 million each for HMC-site, off-site disposal cell, transportation route)
>
> Slurry: $2.28 million ($1.14 for HMC-site and off-site disposal cell, assuming no impacts along exposure route)

The costs are highly dependent on the off-site disposal cell location selected, and the requirements of regulations governing both the origin and terminal processes. It is possible that costs could be lower if, for example, surface water is not located near the off-site disposal cell location. For costing purposes, however, a relatively complex situation was assumed, with annual gamma surveys across the transport route. However, costs could escalate if the monitoring indicates a release has occurred or a negative effect to the environment is noted and requires investigation and correction.

6.3.2.4 Remedial Action Design

Remedial action design includes engineering and construction design of the buildings, infrastructure, and utilities needed to implement the off-site disposal alternative. Support systems such as leak detection systems, emission detection, wind speed monitoring systems, and radiation control boundaries must be included in the designs. Costs for this task were estimated from the Moab UMTRA project, increased for actual realized costs, inflation, and increased volume of material to be handled. The design cost is highest for the slurry option because of the process buildings needed at the origin and terminal locations and the water recycle facility that would return reclaimed water to the origin facility, all of which are highly site- and project-specific. Costs are presented in Table 6-4 for this task.

It is possible that costs could be lower than estimated, but no similar projects other than Moab UMTRA project are available for cost comparisons. The Moab UMTRA project selected rail as the transport method, and therefore, final designs were never completed for the truck or slurry pipeline options. Further, it is assumed for the purposes of this cost estimate that 30 miles of transportation route would need to be designed. This adds to the cost, but could be lower if existing routes could be utilized. Conversely, if a longer distance is required or the terminal site is complex, the design costs could escalate.

6.3.2.5 Site Acquisition

Site acquisition is estimated at $20 million for the off-site alternative. There are no comparable efforts on which to base this cost, nor is it possible to assign a value to land without specifying a disposal cell location and transportation route. However, it is a reasonable estimate of cost given the amount of land that the Moab UMTRA project required for its disposal cell site (500 acres), the likelihood of lease or purchase of land associated with transport route, and the possibility of a need to purchase water rights or mineral rights (as the land used for an off-site disposal cell will be permanently unavailable).

6.3.2.6 Remedial Action Field Management

The cost of the remedial action field management task is estimated at $45 million for each of the three transportation scenarios. This value reflects the costs associated with management in the field, from construction of origin and terminal sites, through tailings movement, and final closure of both sites and the transportation route. It is assumed to be required for 15 years (2.5 years of pre- and post-tailings excavation and 10 years of excavation and relocation). Salaries of managers, engineers, and administration, supplies and other direct or indirect costs (such as general office costs, occupancy costs, communications and data processing costs, insurance, taxes, licenses, and fees, etc.) are estimated to cost $1,500,000 per year each for the origin site and terminal site (including oversight of the transport route). At $1.5 million a year, the 15 year cost is $45 million, as shown in Table 6-4.

6.3.2.7 Site Preparation Cost

Site preparation cost was estimated from the Moab project, adjusted for actual realized costs, inflation, and project volume. It is difficult to predict how much preparation would be needed to unless an off-site disposal cell location is identified, but preparation at both the origin and terminal sites would include collecting baseline data, preparing areas for infrastructure and buildings, creating areas for drying beds (at the origin site, approximately 50 acres of land per the Moab UMTRA project), lining the drying beds, creating water holding areas, and constructing petroleum storage areas. Other activities (particularly at the off-site disposal cell location) would include site regrading, off-site disposal cell excavation, water holding areas, petroleum storage areas, and monitoring well installation (including background and downgradient wells at the terminal site and any other wells needed at the origin site). Preparation would be needed along the transportation route and is included under this cost. The calculation of this cost is shown in Table 6-4.

6.3.2.8 Construction Costs

Other construction costs are the second most costly item of the estimated relocation budget (Table 6-5). The construction costs for each transportation scenario include construction of process buildings, infrastructure, staging areas, mechanical equipment, and design revision in the field at both the origin and terminal sites as needed, as well as construction of the transportation route itself. For costing purposes, it was assumed that 30 miles of road, rail, or slurry pipeline would need to be constructed and maintained. Transport facilities, maintenance facilities, fueling facilities, and worker facilities would be needed at both the origin and terminal sites. A contingency of 10 percent was added to the construction costs.

Off-site disposal cell liner costs are included in this cost estimate (excavation of the off-site disposal cell is accounted for in the site preparation costs). The off-site disposal cell is estimated to cover 1,000 acres, assuming 20 feet of tailings topped with an 8-foot cover (estimated height of tailings and cover in the original design of the Moab UMTRA project). At an estimated cost of $3 per square foot of liner, the cost of the liner alone is $130,680,000. The liner, for the purposes of this report, was assumed to be a top layer of HDPE geomembrane, followed by a leak collection and recovery system, underlain by another HDPE geomembrane and either compacted clay or geosynthetic clay. The cost per square foot represents a low- to midrange installed cost for the liner design as estimated by EPA (Carson, 2006). Note that the cost estimates are not specific to uranium tailings, and the specific needs of the disposal cell liner based on site-specific conditions and chemical composition of the tailings could increase the actual cost of a liner. The exact disposal cell liner design would be site-specific, including consideration of all environmental concerns in addition to specifications outlined in 40 CFR 264. The costs presented in this document are based on average transportation distances and typical conditions of a disposal site (such as arid climate, extensive depth to groundwater, and minimal likelihood of seismic activity). Actual costs could rapidly increase with increasing distance to the disposal cell site from the supplier of the liner; remoteness of the disposal cell site; surface water or groundwater at shallow depth; high levels of precipitation; or other site-specific considerations.

The total construction cost for the truck scenario is $255.8 million, largely related to costs to construct 20 miles of road and two access/exit ramps (it was assumed that 10 miles of existing road would be used for transport). Road construction cost per mile was estimated at $2,700,000 per mile, based on highway reconstruction costs published by New Mexico Department of Transportation (NMDOT, 2012) for current projects that range from $2.7 million to $7.25 million per mile. It was also assumed that two access points would be needed. Without establishing a transportation route, it is not possible to predict whether such structures would be needed, but it is a reasonable assumption if I-40 or other public highways are used to travel to the disposal cell location. Road maintenance, repair, inspection, and permitting was estimated to cost $640,000 over the life of the project, based on the cost of road maintenance of $16,000/mile and the assumption that 4 miles of road could need repair or maintenance per year. This would include any repairs that would be required to public roads that are utilized and that were not necessarily built to withstand the high traffic demands of this project and heavy weight of 150 truckloads of tailings per day. Building construction at both the original and terminal sites is estimated to total $18 million ($9 million per location), including capital costs, labor, annual maintenance, and fencing, constructing transport loading facilities, transport maintenance facilities, worker facilities, fueling facilities, and annual maintenance of each facility.

The total construction cost for the rail scenario is $263.4 million, largely related to the cost of building and maintaining 30 miles of rail. This estimate does not include the cost of constructing a railroad bridge which could be necessary; however, bridge construction costs for railroads are quite project-specific and an average cost estimate could not be located. Rail repair and maintenance is estimated at $17,790 per mile. Tt is assumed that 30 miles of track would be inspected annually and repaired as needed for a total of $5.3 million over the life of the project. Building construction at both the origin and terminal sites is estimated to total $28.4 million ($14.2 million per location), including capital costs, labor, construction of transport loading facilities, construction of maintenance facilities, construction of worker facilities, construction of fuel facilities, and annual maintenance of each facility.

Total construction costs for the slurry pipeline transportation scenario is $333.6 million. The slurry pipeline costs include a double-walled pipeline system for both slurry and return water lines. The inner pipe would be HDPE of a thickness designed to withstand the abrasive nature of slurry, although a thinner HDPE pipe would be used for the return water line. The HDPE pipe would be surrounded by a steel pipe to prevent accidental release in the event of failure of the HDPE pipe. A midline booster pump station was also included in the estimate. The pipeline costs reflect mainly the cost of materials. Labor was arbitrarily estimated at $2 million for the construction period ($66.667 per mile).

The slurry pipeline construction cost was estimated to total $130.3 million. Annual maintenance of the pipeline was estimated to cost $8 million over the life of the project ($200,000 per mile, 4 miles per year for 10 years), which would also include inspection of the entire length of the pipeline on a regular basis. Building construction at both the origin and terminal sites is estimated to total $49.4 million ($24.7 million per location), including capital costs; labor; construction of transport loading facilities; construction of maintenance facilities; construction of worker facilities; construction of fuel facilities; and annual maintenance of each facility. The slurry facility and both the origin and terminal locations are difficult to price without specific performance standards and volume requirements, and costs are likely underestimated.

6.3.2.9 Transportation Equipment, Labor, and Maintenance

The project lifetime costs of each transportation scenario were estimated assuming annual fuel consumption, salaries, and maintenance, as well as initial capital costs. The estimated calculations are presented in Table 6-6 for trucking; Table 6-7 for rail transportation; and Table 6-8 for slurry transport. For truck transportation, the estimated total was $76.0 million, assuming an initial capital cost of $5.5 million and annual costs of $7.2 million. A ten percent contingency was included in the cost, to reflect the likely rise in cost of fuel, maintenance, and salaries over time. For rail transportation (Table 6-7), capital costs were estimated at $12.6 million and annual costs at $2.9 million for a total of $41.5 million with a 10 percent contingency. The cost difference between rail and truck transport is largely due to higher fuel consumption and larger work force (increased total salary) for trucking as compared to rail transport.

The slurry transportation option (Table 6-8) is estimated to cost a total of $31.8 million. The capital costs were estimated at $8.9 million, which includes haul trucks that would be needed and the return water ponding and water handling equipment that is assumed to be needed to return or treat water extracted from slurry. Salaries, fuel, return water line maintenance, and haul truck maintenance are estimated to cost over $2.3 million per year, for a total of $23 million over the 10 year transportation span. With a 10 percent contingency, the total estimated cost for slurry transportation is $31.8 million.

6.3.2.10 Tailings Handling

The cost of tailings handling was estimated separately for each transportation scenario, with rail costs being the highest at $795 million, slurry at $620.8 million, and truck at $591.3 million (Table 6-9). The costs are not based on the transportation itself (discussed in Section 6.3.2.9), but rather the preparation of movement of tailings from the current Large Tailings Pile, to staging or drying areas, loading into the trucks, railcars, or conveyor belts, and then unloading and moving the tailings to the off-site disposal cell after arrival at the terminal location. The work would be performed using backhoes, bulldozers, or other earth-moving equipment that meets the project needs.

Both the truck and rail options would likely involve drying the tailings prior to transportation. Tailings would first be moved from the Large Tailings Pile to drying beds. Dried tailings would then be loaded to trucks or railcars. Loading the tailings to trucks would presumably be the most efficient because they could be loaded with fewer staging areas and transport the tailings closest to the disposal cell without transferring their contents. Moving dried tailings to railcars could involve a second staging area to transport tailings from the drying area beds to loading areas and then from loading areas to rail cars. Trucks could also transport tailings closer to the final disposal cell before unloading tailings to a staging area. Assuming the same design parameters as used in the Moab UMTRA project FEIS, the rail cars would be mechanically dumped at the terminal location to a holding area below the track level, where they would then be loaded to haul trucks and placed in the off-site disposal cell by appropriate equipment. The total cost per cubic yard of tailings movement by truck was estimated at $18.15 and $47 for rail transport, because of the loading and unloading of rail cars through staging areas and use of haul trucks to transport tailings from the rail to a staging area for placement into the off-site disposal cell. In addition, decontamination of the rail cars is expected to be more difficult than trucks given the size of each and the facilities needed, adding to the cost of handling.

The slurry method of transportation assumes an equal amount of material to be moved per day as the rail and truck options. Conceptually, tailings would need to be moved from the Large Tailings Pile to a staging area, where they could be then be loaded to a conveyor. This is assumed to be lower in cost per square yard of material than reloading trucks or rail cars. Tailings moved by slurry would be vacuum dried at the terminal process building prior to placement in the off-site disposal cell, which increases costs relative to other options and involves more construction costs prior to any tailings handling. Handling tailings through a slurry facility is estimated to cost $21 per cubic yard.

6.3.2.11 Cover Material

Cover material would be needed to cap the off-site disposal cell, backfill the excavation of the Large Tailings Pile footprint, and cap the Large Tailings Pile footprint. For the purposes of the cost estimate, shown in Table 6-10, it was assumed that all cover material would need to be transported to the origin and terminal sites by truck from a commercial source. This assumption was made because, without specifying and studying an off-site disposal cell location, it is not possible to decide whether any soil excavated for the off-site disposal cell would be suitable cover material. It was assumed that commercial available cover material (soil, gravel, and rock) would cost $15 per cubic yard and that each transport trip would cost $828 dollars. Based on the estimated size of the Large Tailings Pile footprint and the depth of cover needed for the cover of the off-site disposal cell, approximately 3.5 million cubic yards of material would be needed.

6.3.2.12 Erosion Protection

Erosion protection is needed to prevent the cover of the off-site disposal cell and the origin site from degrading and being breached by an intrusive force. The cost for erosion protection was estimated from the Moab UMTRA project FEIS, which had estimated $4.1 million. Project experience at Moab has indicated that costs have tripled since the 2003 estimate. Therefore, this estimate was tripled, adjusted to account for inflation, and increased 25 percent to account for the larger volume of tailings in the Large Tailings Pile as compared to the Moab site. The estimate used here is $20.2 million to design, construct, and maintain an erosion cover that should last 1,000 years at two locations (approximately $10.1 million each for the origin and terminal locations), as shown in Table 6-2.

6.3.2.13 Site Restoration

Site restoration would begin after transportation of tailings is completed. Site restoration would involve demolition of buildings and structures no longer needed, disposal of residual radioactive materials and materials that could not be decontaminated. It would also include remediation of any unintended impacts caused by the tailings handling and transportation. The costs associated with site restoration were estimated from the Moab FEIS document, as site-specific costs cannot be calculated unless an off-site disposal cell location is designated and designs for processes are taken beyond a conceptual stage. Based on the Moab UMTRA project estimated costs (DOE, 2005), actual realized costs (DOE, 2009), adjustment for inflation and volume of tailings, the estimated site restoration cost is $26.7 million for the truck transportation scenario, $31.4 million for the rail scenario, and $39.8 million for the slurry scenario (Table 6-2).

6.3.2.14 Surveillance and Maintenance

Surveillance and maintenance costs were estimated at $4.2 million for the life of the project (Table 6-2), which is exclusive of transport equipment maintenance costs. The surveillance and maintenance costs include security and administration building maintenance, based on a current annual cost of approximately $280,000 for the HMC-Grants Site, doubled to include two sites (origin and terminal sites) and increased 50 percent to account for larger facilities and potentially greater resource use.

6.3.2.15 Project Management

Project management for implementing the off-site disposal alternative would include non-field work administration (Table 6-2). It was assumed that eight people would be employed full-time to manage personnel, and attend to legal and administrative issues of the project at an average hourly rate of $155.40 per hour, including salary and other direct and indirect costs. Project management would span 20 years, as 5 years of management may be needed prior to and after tailings movement to address all environmental, construction, permitting, licensing, and site closure issues.

6.3.2.16 Summary

The total cost for implementing the off-site disposal alternative is projected to be $1.52 billion for the truck scenario, $1.52 billion for the rail scenario and $1.86 billion for the slurry pipeline scenario. A 15 percent contingency per NRC guidance was added to the total for each, plus a $1.6 million for NRC long-term maintenance and surveillance fee (estimated cost) for estimated cost totals of $1.75 billion for truck transportation, $2.01 billion for rail transportation and $2.13 billion for slurry transportation, as shown in Table 6-2.

The costs are estimated based on limited available information. Costs for implementing the off-site disposal alternative would be highly dependent on the off-site disposal cell location as well as the transportation scenario selected. It is not possible to predict all obstacles that could be faced in such an extensive undertaking, and costing information for many of the tasks involved is highly variable and must be based on site-specific considerations. Nonetheless, the costs presented here are consistent with the more recent cost-to-complete estimates from the Moab UMTRA project (DOE, 2009). More specific plans would produce a more specific cost estimate.

Table 6-2. Cost Estimate (in millions of dollars)

Remedial Action Component	On-Site Alternative (1)	Off-site Alternative		
		Truck	Rail	Pipeline
Tailings Facility Closure/Reclamation	$14.3	$13.3	$13.3	$13.3
Other On-site Demolition	$0.2	$0.2	$0.2	$0.2
On-site Water Treatment	$12.5	$12.5	$12.5	$12.5
On-Site Monitoring/Regulatory	$1.8	$1.8	$1.8	$1.8
On-Site Administrative, General, Security, Maintenance, and Holding	$6.3	$6.3	$6.3	$6.3
Subtotal	$35.0	$34.0	$34.0	$34.0
Siting Studies/EIS	NA	$12	$12	$12
Site Characterization (2)	NA	$7.5	$7.5	$7.5
Environment, Health and Safety, NEPA	NA	$78.8	$80.2	$45.5
Remedial Action Design (2)	NA	$9.4	$9.4	$28.1
Site Acquisition (3)	NA	$20	$20	$20
Remedial Action Field Management	NA	$45	$45	$45
Site Preparation (2)	NA	$149.1	$191.7	$404.5
Construction Costs (4)	NA	$255.9	$263.4	$350.3
Transportation Equipment, Fuel. Labor, and Maintenance	NA	$76.0	$41.5	$31.8
Tailings Handling	NA	$591.3	$795.0	$620.9
Cover Material	NA	$142.0	$142.0	$142.0
Erosion Protection (2)	NA	$20.2	$20.2	$20.2
Site Restoration (2)	NA	$26.7	$31.4	$39.8
Surveillance and Maintenance (5)	NA	$4.2	$4.2	$4.2
Project Management	NA	$49.7	$49.7	$49.7
Total	$44.8	$1521.7	$1747.2	$1855.6
15% Contingency	$6.7	$228.3	$262.1	$278.3
NRC Long-Term Maintenance/Surveillance Fee (6)	$0.8	$1.6	$1.6	$1.6
TOTAL	$52.3	$1,751.6	$2,010.8	$2,135.5

(1) On-site alternative costs are from HMC-Grants 2011 NRC-approved budget estimates. Note that the HMC-Grants closure/reclamation budget shown for the off-site alternative was decreased by $1 million for the off-site design alternative to account for exclusion of the LTP cap.

(2) Off-site alternative costs are based on cost estimates provided in the Final EIS for Moab (2005), tripled to account for adjustments made to Moab budget after 2007 that indicated an approximate threefold increase in total project costs from original estimates, plus a 25 percent increase to account for inflation from 2003 to 2012 (http://www.usinflationcalculator.com/), and 25 percent increase to account for larger mass of material to be moved.

(3) An estimate of purchasing land, mineral rights, water rights, and lease of any land needed for access roads, rail or slurry construction.

(4) Construction costs include all costs associated with construction and maintenance of process and transport buildings and equipment at both origin and terminal locations, and construction and maintenance of the transport route.

(5) Based on general maintenance costs to end of project (office maintenance, etc.) and surveillance/security costs for both origin and terminal locations.

Table 6-3. Siting Studies and EIS Costs

Siting Studies				
Preliminary Siting				
Task	**Unit Cost**	**Quantity**	**Value**	**Source and Assumptions**
Kickoff Meeting and Initial Site Visit	$25,000	1	$25,000	Similar Projects
Develop Project Management Plan	$6,000	1	$6,000	Similar Projects
Public Participation Plan	$7,500	1	$7,500	Similar Projects
Research for Initial Identification of Sites	$100,000	1	$100,000	Similar Projects
Public Meetings at each Potential Relocation Site	$10,000	10	$100,000	10 sites, 4 HMC representatives at each meeting
Report detailing 5 potential sites	$65,000	1	$65,000	Similar Projects
Public meetings at each detailed site	$10,000	5	$50,000	5 site, 4 HMC representatives at each meeting
Regulatory Agency/Stakeholder Meetings	$10,000	5	$50,000	Similar Projects
Administrative Record	$65,000	1	$65,000	Required
Project Management	$200	450	$90,000	Hourly wage including direct and indirect costs
		Task Total	*$558,500*	
Preliminary Site Investigations				
Task	**Unit Cost**	**Quantity**	**Value**	**Source and Assumptions**
SAP, QAPP, SSHP	$65,000	1	$65,000	Similar Projects
Soil Characterization	$50,000	5	$250,000	Preliminary Investigation at 5 sites
Groundwater Characterization	$50,000	5	$250,000	Preliminary Investigation at 5 sites
Surface Water Characterization	$25,000	5	$125,000	Preliminary Investigation at 5 sites
Ecological Survey	$35,000	5	$175,000	Preliminary Investigation at 5 sites
Socioeconomic Surveys	$20,000	5	$100,000	Preliminary Investigation at 5 sites
Public meetings at each detailed site	$10,000	5	$50,000	Preliminary Investigation at 5 sites
Regulatory Agency/Stakeholder Meetings	$10,000	5	$50,000	Similar Projects
Administrative Record	$65,000	1	$65,000	Required
Project Management	$200	450	$90,000	Hourly wage including direct and indirect costs
		Task Total	*$1,220,000*	
Regulatory Oversight				
Regulatory Oversight Fees	$450,000	5	$2,250,000	5 years of oversight for this task; estimated unit cost
		Task Total	*$2,250,000*	

Siting Studies				
Preliminary Engineering Designs				
Task	**Unit Cost**	**Quantity**	**Value**	**Assumptions**
Off-site Disposal Cell Design	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
Off-site Disposal Cell Design - Staging areas	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
Off-site Disposal Cell Design - Equipment/Material Storage Areas	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
Transportation Design - Slurry, Rail, and Truck	$200	2880	$576,000	Similar projects; $200/hr salary + direct and indirect costs; 960 hours for each transportation mode
Off-site Disposal Cell Site - Design of Facilities/Buildings	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
HMC Grants Site - Design of Facilities/ Buildings	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
HMC Grants Site - Design of Staging areas	$200	960	$192,000	Similar projects; $200/hr salary + direct and indirect costs
		Task Total	*$1,728,000*	
EIS				
Task	**Unit Cost**	**Quantity**	**Value**	**Assumptions**
Kickoff Meeting and Site(s) Visits	$25,000	1	$25,000	Similar projects
Develop Project Management Plan	$6,000	1	$6,000	Similar projects
Public Participation Plan	$7,500	1	$7,500	Similar projects
Scoping	$25,000	1	$25,000	Similar projects
Draft EIS	$150,000	5	$750,000	3 potential disposal sites, HMC Grants Site, plus transportation corridor; at $150,000 per location
Public Comment of Draft EIS	$65,000	1	$65,000	Similar projects
Stakeholder Meetings	$10,000	5	$50,000	Similar projects
Response to Comments	$50,000	1	$50,000	Similar projects
Prepare Draft Final EIS	$100,000	5	$500,000	Public may ask for additional alternatives to be evaluated (i.e., - underground disposal options) that will need to be evaluated with other alternatives
Public Comment of Draft EIS	$65,000	1	$65,000	Similar projects
Stakeholder Meetings	$50,000	1	$50,000	Similar projects
Response to Comments	$50,000	1	$50,000	Similar projects
Prepare Final EIS	$150,000	1	$150,000	Similar projects
Administrative Record	$65,000	1	$65,000	Negotiation of ROD to finalize selection of remedy; Federal Register
Project Management	$200	450	$90,000	Similar projects; $200/hr weighted hourly and 450 hours
		Task Total	*$1,948,500*	

Siting Studies				
Other Regulatory Costs				
Task	**Unit Cost**	**Quantity**	**Value**	**Assumptions**
Other Regulatory Costs	850,000	5	$4,250,000	Negotiations, permitting, licenses, other reports required regulatory agencies; consultant fees, internal costs
		Task Total	*$4,250,000*	
Total Cost of Tasks				**$11,955,000**

Table 6-4. Site Characterization, Environmental, Health and Safety, and NEPA Tasks, and Remedial Action Field Management Estimated Costs

Site Characterization				
Moab Cost Basis	**Adjust for Actual Expense**	**Inflation and Volume Increase (each)**	**Total**	**Source and Assumptions**
$1,600,000	3	1.25	$7,500,000	Moab 2005 FEIS estimates and subsequent budget requests
Environmental, Health and Safety, NEPA				
	Adjust for Actual Expense	**Inflation and Volume Increase (each)**	**Total**	**Source and Assumptions**
Moab Cost Basis-Truck				
$16,800,000	3	1.25	$78,750,000	Moab 2005 FEIS estimates and subsequent budget requests
Moab Cost Basis-Rail				
$17,100,000	3	1.25	$80,156,250	Moab 2005 FEIS estimates and subsequent budget requests
Moab Cost Basis-Slurry				
$9,700,000	3	1.25	$45,468,750	Moab 2005 FEIS estimates and subsequent budget requests
Remedial Action Design				
Moab Cost Basis	**Adjust for Actual Expense**	**Inflation and Volume Increase (each)**	**Value**	**Source and Assumptions**
$2,000,000	3	1.25	$9,375,000	Moab 2005 FEIS estimates and subsequent budget requests
Site Acquisition				
Cost Basis			**Value**	**Source and Assumptions**
$20,000,000			$20,000,000	Based on assumed cost of purchasing or leasing land
Remedial Action Field Management				
Cost Basis	**Sites**	**Years (1)**	**Value**	**Source and Assumptions**
$1,500,000	2	15	$45,000,000	Salary, direct and indirect costs of field management for 2 sites for 15 years
Site Preparation				
Moab Cost Basis	**Adjust for Actual Expense**	**Inflation and Volume Increase (each)**	**Value**	**Source and Assumptions**
$1,700,000	3	1.25	$7,968,750	Moab 2005 FEIS estimates and subsequent budget requests

(1) 2.5 years of pre- and post-tailings excavation, plus 10 years of tailings excavation

Table 6-5. Construction Costs

Construction Costs				
Origin and Terminal Construction Costs (1)				
Task	**Truck**	**Rail**	**Slurry**	**Source and Assumptions**
On-site transport facilities	$4,000,000	$9,200,000	$19,700,000	Construction, capital costs; supplies, labor, annual maintenance and other costs for 20 years
On-site maintenance facilities	$4,000,000	$4,000,000	$4,000,000	
On-site worker facilities	$1,000,000	$1,000,000	$1,000,000	
Off-site transport facilities	$4,000,000	$9,200,000	$19,700,000	
Off-site maintenance facilities	$4,000,000	$4,000,000	$4,000,000	
Off-site worker facilities	$1,000,000	$1,000,000	$1,000,000	
Off-site Disposal Cell Liner	$130,680,000	$130,680,000	$130,680,000	43,560,000 square feet at $3/square foot (5)
Subtotal	$148,680,000	$159,080,000	$180,080,000	
Transport Route Construction Costs				
Task	**Unit Cost per Mile**	**Quantity (mile)**	**Value**	**Source and Assumptions**
Truck Roads	$2,700,000	20	$54,000,000	NMDOT 2012 (based on published projects)
Railroad	$2,500,000	30	$75,000,000	American Association of Railroads, 2009
Slurry	$3,844,929	30	$115,347,872	Vendor information for material (4); labor estimated
Truck - highway access, over pass, or bridge	$130	225,000	$29,250,000	$130/sf; 4 structures, at 44 feet wide and 45 feet long; Florida DOT
Midline Pump Station (slurry)	$15,000,000 (each)	1	$15,000,000	Similar project
Maintenance, Repair, Inspection, Permits				
Task	**Unit Cost per Mile**	**Quantity (miles per year for 10 years)**	**Value**	**Source and Assumptions**
Truck (2)	$16,000	40	$640,000	4 miles per year for 10 years
Railroad (3)	$17,790	300	$5,336,940	30 miles of track for 10 years (Grimes and Barkan, 2006)
Slurry	$200,000	40	$8,000,000	4 miles per year for 10 years; assumed cost
Totals for Transportation and Site Construction				
Task	**Truck**	**Rail**	**Slurry**	**Assumptions**
Total of all Tasks	$232,570,000	$239,416,940	$303,427,872	
10% Contingency	$23,257,000	$23,941,694	$30,342,787	Common construction contingency
Grand Total	**$255,827,000**	**$263,358,634**	**$333,770,657**	

(1) Assumes rail and truck options would require extensive drying pad areas and slurry option requires more processing buildings, equipment, and water processing facilities. Fencing of origin and terminal locations included in costs.
(2) Road maintenance average cost estimated from: http://www.sacog.org/mtp/pdf/MTP2035/Issue%20Papers/Road%20Maintenance.pdf
(3) Rail track maintenance cost from Grimes and Barkan (2006); based on $1358 per million gross ton mile (2012 dollars) and 36,000 tons per day, 365 days per year, 30 miles per day for 10 years.
(4) Vendor supplied information for HDPE pipe and steel pipe for both slurry and water pipelines.
(5) Mid-range cost of an installed liner consisting of geomembrane, followed by a compacted or geosynthetic clay layer, then a geomembrane (Carson, 2006).

Table 6-6. Truck Transportation Cost Estimates

Quantity Estimates				
Item	**Unit**		**Value**	
Material to be Removed	tons		22,000,000	
Tons per Truck	tons/load		40	
Years to Complete	years		10	
Quantity per year	tons/year		2,200,000	
Truckloads per year	loads/year		55,000	
Roundtrip Distance to Off-site Disposal Location	miles/load		60	
Miles traveled per year	miles/year		3,300,000	
Gallons of fuel consumed, per year @ 6 mpg	gallons/year		550,000	
Weeks of operation per year	weeks/year		52	
Truckloads per week	loads/week		1,058	
Days operating	days/week		7	
Truckloads per day	loads/day		151	
Average roundtrip truckloads per day	loads/day		4	
# of Trucks	trucks		40	
# of Drivers Required	drivers		60	
Capital Cost				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Capital Cost for Fleet of Trucks	per truck	$125,000	40	$5,000,000
Contingency	%	10%	1	$500,000
			Total Capital Cost	**$5,500,000**
Annual Costs				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Driver Salaries	annual salary	$65,000	60	$3,900,000
Truck Maintenance	$/mile traveled	$0.10	3,300,000	$330,000
Annual Fuel Cost	$/gallon	$4.13	550,000	$2,271,500
Contingency	%	10%	1	$650,150
			Total Annual Cost	**$7,151,650**
Total Cost Present Worth				
			Total Capital Cost	**$5,500,000**
			Present Worth Annual Cost for 10-year Period	**$70,542,902**
			Total Present Worth of Truck Transportation	**$76,042,902**

Assumptions
Average salary assumed truck driver with CDL in New Mexico
Assumes 6 mpg for haul trucks
Assumes cost of truck is $125,000
Number of drivers is assumed to be based on 240 normal work year
Annual fuel based on average cost as of 4/10/2012 for Rocky Mountain region
Truck maintenance assumes $0.10 per miles traveled

Table 6-7. Rail Transportation Cost Estimate

Quantity Estimates				
Item	**Unit**		**Value**	
Material to be Removed	tons		22,000,000	
Tons per Train	tons/load		3,000	
Years to Complete	years		10	
Quantity per year	tons/year		2,200,000	
Truckloads per year	loads/year		733	
Roundtrip Distance to Off-site Disposal Location	miles/load		60	
Miles traveled per year	miles/year		44,000	
Gallons of fuel consumed, per year @ 250 gal per RT	gallons/year		182,500	
Weeks of operation per year	weeks/year		52	
Trainloads per week	loads/week		14	
Days operating	days/week		7	
Trainloads per day	loads/day		2	
Average roundtrip truckloads per day	loads/day		2	
# of cars	rail car		30	
# of Drivers Required	drivers		4	
Capital Cost				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Capital Cost for Rail cars	per car	$100,000	40	$4,000,000
Capital Cost for Locomotive	per car	$2,500,000	3	$7,500,000
Contingency	%	10%	1	$1,150,000
Total Capital Cost				$12,650,000
Annual Costs				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Terminal Employee Salaries	annual salary	$65,000	23	$1,495,000
Engineer Salaries	annual salary	$80,000	4	$320,000
Rail Car Maintenance	$/mile traveled	$0.84	21,900	$18,396
Locomotive Maintenance	$/mile traveled	$3.17	21,900	$69,423
Annual Fuel Cost	$/gallon	$4.13	182,500	$753,725
Contingency	%	10%	1	$265,654
Total Annual Cost				$2,922,198
Total Cost Present Worth				
Total Capital Cost				$12,650,000
Present Worth Annual Cost for 10-year Period				$28,824,167
Total Present Worth of Rail Transportation				$41,474,167

Assumptions
Average salaries of train engineers and staff
Assumes cost of rail car is $100,000 and locomotive is $3,000,000. Actual cost cannot be determined without rail specifications
Number of engineers is assumed to be based on normal work year and time constraints of project
Annual fuel based on average cost as of 4/10/2012 for Rocky Mountain region
Maintenance costs from published commuter rail study; may be less for freight cars

American Railroad Association states freight trains can move material at 484 ton-mile per gallon of fuel.
3000 tons per day 30 mile - 90,000 ton-mile
Fuel use per one way, fully loaded trip is = 185.9504132
250 gallons roundtrip (estimate) per trip; return trip is empty weight
http://www.aar.org/~/media/aar/Background-Papers/Freight-RR-Help-Reduce-Emissions.ashx
Locomotive and rail car maintenance estimates from http://www.dot.state.tx.us/mis/aus-sat/asrstudy.htm

Table 6-8. Slurry Transportation Cost Estimate

Quantity Estimates				
Item	**Unit**		**Value**	
Material to be Removed	tons		22,000,000	
Years to Complete	years		10	
Quantity per year	tons/year		2,200,000	
Roundtrip Distance to Off-site Disposal Location	miles/load		60	
Gallons of fuel consumed, per year	gallons/year		1,798	
Weeks of operation per year	weeks/year		52	
Days operating	days/week		7	
Capital Cost				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Capital Cost for Holding Ponds/Water Handling Equipment	each	$1,750,000	4	$6,600,000
Capital Cost for Haul Trucks	truck	$150,000	10	$1,500,000
Contingency	%	10%	1	$810,000
			Total Capital Cost	**$8,910,000**
Annual Costs				
Item	**Unit**	**Unit Cost**	**Quantity**	**Subtotal**
Employee salaries	annual salary	$65,000	25	$1,625,000
Haul Truck Maintenance	annual cost	$18,000	10	$180,000
Water Return Line Maintenance	$/mile	$10,000	30	$300,000
Annual Fuel Cost	$/gallon	$4.13	1,798	$7,426
Contingency	%	10%	1	$211,243
			Total Annual Cost	**$2,323,668**
Total Cost Present Worth				
			Total Capital Cost	**$8,910,000**
			Present Worth Annual Cost for 10-year Period	**$22,920,348**
			Total Present Worth of Slurry Transportation	**$31,830,348**

Assumptions
Truck maintenance assumes general replacement and repair costs for haul trucks from slurry facility to disposal cell.
Slurry pipeline construction presented in other construction costs.
Slurry fuel consumption based on Moab UMTRA project.

Table 6-9. Tailings Handling Costs

Truck				
Labor, Equipment, and Fuel per Task	**Cost per CY**	**CY per day**	**Value**	**Source and Assumptions**
Moving tailings from pile to drying area at HMC-Grants Site	$5	8,100	$40,500	Similar Projects
Load tailings	$5	8,100	$40,500	Similar Projects
Moving tailings from truck to staging area	$5	8,100	$40,500	Similar Projects
Moving tailings from staging area to Off-site Disposal Cell	$3.15	8,100	$25,515	Similar Projects
Inspection/Decontamination (per vehicle)	$100	150	$15,000	$100 per truckload, 150 truckloads per day
		Cost per day	**$162,015**	
		Cost per year	**$59,135,475**	
		10 Years	**$591,354,750**	
Rail				
Labor, Equipment, and Fuel per Task	**Cost per CY**	**CY per day**	**Value**	**Source and Assumptions**
Moving tailings from pile to drying area at HMC-Grants Site	$5	8,100	$40,500	Similar Projects
Moving tailings from drying area to staging area	$10	8,100	$81,000	Similar Projects
Moving tailings onto railcar	$5	2,250	$11,250	Similar Projects
Moving tailings from railcar dump to haul truck	$10	2,250	$22,500	Similar Projects
Moving tailings by haul truck to Off-Site Disposal Cell	$10	3,780	$37,800	Similar Projects
Placement of tailings in Off-Site Disposal Cell	$7	2250	$15,750	Similar Projects
Decontamination and survey of railcars	$220	40	$8,800	30 railcars plus 30% re-wash/re-inspect; estimated cost per vehicle
		Cost per day	**$217,600**	
		Cost per year	**$79,424,000**	
		10 Years	**$794,240,000**	

Slurry				
Labor, Equipment, and Fuel per Task	**Cost per CY**	**CY per day**	**Value**	**Source and Assumptions**
Move tailings to staging area at HMC-Grants Site	$5	8100	$40,500	Similar Projects
Move tailings from staging area onto conveyor belt	$4	8100	$32,400	Similar Projects
Tailings through origin slurry facility (CY per day assumed equal to truck)	$2	8100	$16,200	Similar Projects
Tailings from terminal slurry facility to Off-Site Disposal Cell (includes vacuum drying, hauling tailings, waste water recycle and return)	$10	8100	$81,000	Similar Projects
		Cost per day	**$170,100**	
		Cost per year	**$62,086,500**	
		10 Years	**$620,865,000**	

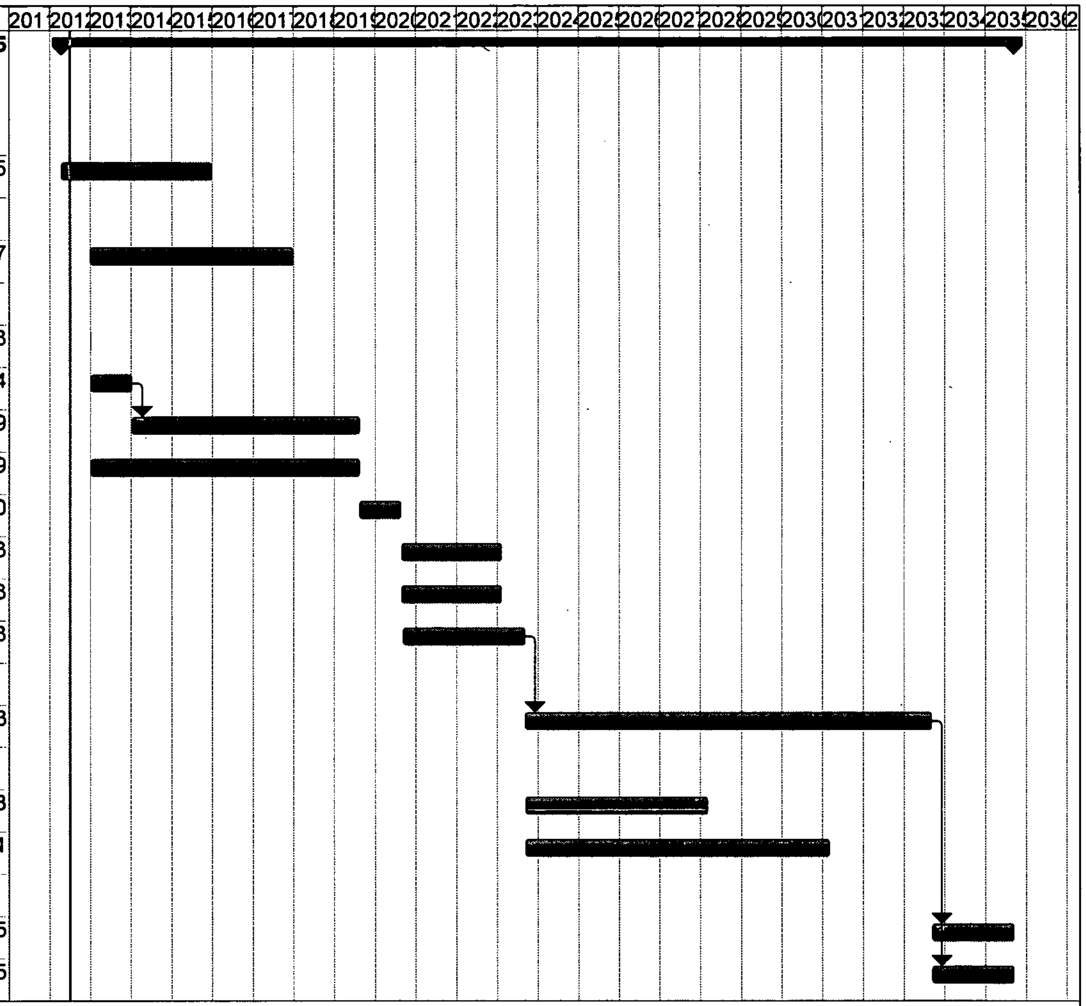
CY = cubic yard

Table 6-10. Cover Material

Commercial Source of all Cover Material				
Cover Material	**Cost per CY**	**CY**	**Value**	**Source and Assumptions**
Origin site (footprint)	$15	2,245,188	$33,677,820	Assumed commercial cost of materials
Off-Site Disposal Cell	$15	1284213	$19,263,195	Assumed commercial cost of materials
Transport	**Cost per Trip**	**Trips per Life of Task**	**Value**	**Source and Assumptions**
Trip Cost	$868	102,643	$89,094,124	Similar Projects; cost of delivery, fuel, etc.
		Total	**$142,035,139**	

Cost per cubic yard is an estimate of all materials purchased from a commercial vendor.
Trip cost highly dependent on distance from commercial vendor location to original site and Off-Site Disposal Cell.

ID	Task Name	Start	Finish
1	**Off-Site Alternative for Homestake-Grants Site**	**Thu 4/12/12**	**Wed 9/12/35**
2	Groundwater Remediation	Thu 4/12/12	Thu 12/31/15
3			
4	Evaporation Pond and RO plant closure	Mon 12/31/12	Fri 12/29/17
5			
6	Off-site Alternative	Mon 1/7/13	Mon 1/7/13
7	Siting Studies	Mon 1/7/13	Mon 1/6/14
8	EIS/EAs	Tue 1/7/14	Mon 8/12/19
9	Public meetings	Mon 1/7/13	Mon 8/12/19
10	I year Monitoring of Relocation Site	Mon 8/12/19	Mon 8/17/20
11	Construction of On-site Infrastructure	Mon 8/24/20	Mon 2/6/23
12	Construction of Transport Route	Mon 8/24/20	Mon 2/6/23
13	Construction of Off-site Infrastructure	Mon 9/7/20	Mon 9/4/23
14			
15	Transport of Tailings	Tue 9/5/23	Tue 9/6/33
16			
17	Transport of Borrow Materials - On-site	Mon 9/11/23	Mon 3/6/28
18	Transport of Borrow Materials - Off-site	Mon 9/11/23	Mon 3/3/31
19			
20	Cap and Closure of HMC-Grants Site	Mon 9/12/33	Wed 9/12/35
21	Cap and Closure of Disposal cell	Mon 9/12/33	Wed 9/12/35



Project: timeline 2012-06-29
Date: Fri 6/29/12

Task	External Milestone	Manual Summary Rollup
Split	Inactive Task	Manual Summary
Milestone	Inactive Milestone	Start-only
Summary	Inactive Summary	Finish-only
Project Summary	Manual Task	Progress
External Tasks	Duration-only	Deadline

Figure 6-1. Estimated Timeline of Disposal Alternative

6.4 Consequences of Uncertainty

The purpose of this report was to tabulate potential costs, risks, and impacts from an off-site tailings disposal alternative, as compared to the current plan for the HMC-Grants Site closure (the on-site alternative). As such, assumptions had to be made in order to provide a framework of discussion. All attempts were made to generate assumptions based on known factors at the HMC-Grants Site, bounding estimates of distance and time, and both the estimates and realized costs from the Moab UMTRA project, the most comparable project available for comparison. In general, the consequences of uncertainty in this evaluation are that risks or costs may have been underestimated and there may be higher impacts to human health and the environment.

Most of the consequences of uncertainty are associated with the off-site disposal alternative. Construction accidents, transportation accidents that release radioactive material, windblown dispersion of particulates, radon emissions, gamma exposure, large consumption of fossil fuels with concurrent greenhouse gas emissions, and potential failure of a disposal cell can only happen if tailings are transported off the HMC-Grants Site. The extent of these consequences is uncertain but the potential for their occurrence is not. In the average to best-case scenarios, exposures and accidents are minimal, and the off-site disposal cell failure does not occur. However, it is unlikely that accidents would not occur. Exposure to particulates, radon, and gamma can only be minimized; they cannot be avoided if the tailings pile is excavated.

Another source of uncertainty is the time it would take to complete the off-site disposal project. An estimate of 10 years has been used for this report. However, the same estimate was used for Moab, and after three years of tailings pile relocation, 32 percent of the pile has been relocated only due to a two-year tripling of the workforce made possible by a $108 million award of American Recovery and Reinvestment Act funding; estimates are now that the remaining tailings could take over 12 years to move, for a total of 15 years. Since the HMC-Grants Large Tailings Pile is 25 percent larger than the Moab tailings pile, it is likely that the move of the Large Tailings Pile could take almost 20 years. In such a case, the exposure period to particulates, radon, and gamma could be twice that predicted here and would raise total risk and dose estimates. It also becomes more likely that traffic accidents would occur. Solid and sanitary waste generation would occur at both the HMC-Grants Site and the off-site disposal cell location for a longer period of time than under the on-site closure alternative.

The use of a larger amount of resources, fuel, and materials is certain under the off-site alternative. The use of fuel and electricity will result in greenhouse gas emissions, dust will be generated, solid and sanitary wastes will be generated, and additional equipment and materials will become radioactively contaminated and may need to be disposed of if they cannot be decontaminated. The total amount of such wastes and emissions may vary from estimates presented here but will certainly be extensive, irretrievable and much higher than the amount generated under the on-site alternative.

The costs estimated below are also based on assumptions that may change over time. In particular, the capital costs of construction material, steel, and fuel are likely to rise and the amount needed will depend on the location of the off-site disposal cell. Material specifications may drive the costs higher than those used here.

6.5 Other Considerations

Unlike the Moab site, there is no clear goal in relocating the Large Tailings Pile from its current location. Based on the risks of traffic and construction accidents alone, it is likely that relocation of the tailings pile may result in a fatality. The off-site disposal alternative will result in a higher risk of cancer to on-site workers and area residents than leaving the Large Tailings Pile in place.

Greenhouse gas emissions are estimated in Table 6-11, below. These estimates are based on the fuel consumption for transport only, and do not include emissions from construction equipment, borrow material trucks, or personal vehicles used by workers. The emissions are highest for truck transportation, and equate to the CO_2 emission for electricity use of 555 homes annually. The CO_2 emissions from trucks would likely double when personal vehicles, borrow material vehicles, and construction equipment are considered.

Table 6-11. Greenhouse Gas Emissions

Transportation Mode	Estimated Gallons Per Year	CO_2 Emissions (tons)
Truck	550,000	4906
Rail	146,000	1302
Slurry Pipeline	1,798	16

To obtain the number of grams of CO_2 emitted per gallon of gasoline combusted, the heat content of the fuel per gallon is multiplied by the kg CO_2 per heat content of the fuel. The average heat content per gallon of gasoline is 0.125 mmbtu/gallon and the average emissions per heat content of gasoline is 71.35 kg CO_2/mmbtu. (EPA, 2010)

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